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Bae et al.

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(54) **METHOD FOR CHECKING CRACK IN DISPLAY AND ELECTRONIC DEVICE FOR PERFORMING SAME**

(71) Applicant: **Samsung Electronics Co., Ltd.**, Gyeonggi-do (KR)

(72) Inventors: **Jongkon Bae**, Gyeonggi-do (KR); **Hyunjun Park**, Gyeonggi-do (KR); **Donghwy Kim**, Gyeonggi-do (KR); **Euntaek Jang**, Gyeonggi-do (KR); **Dongkyoon Han**, Gyeonggi-do (KR); **Yunpyo Hong**, Gyeonggi-do (KR)

(73) Assignee: **Samsung Electronics Co., Ltd.**

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PCT Pub. Date: **Nov. 28, 2019**

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G09G 3/20 (2006.01)

(52) **U.S. Cl.**
CPC ***G09G 3/006*** (2013.01); ***G09G 3/20*** (2013.01); *G09G 2310/0267* (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC G09G 3/00; G09G 3/006; G09G 3/20; G09G 3/035; G09G 2310/0267;
(Continued)

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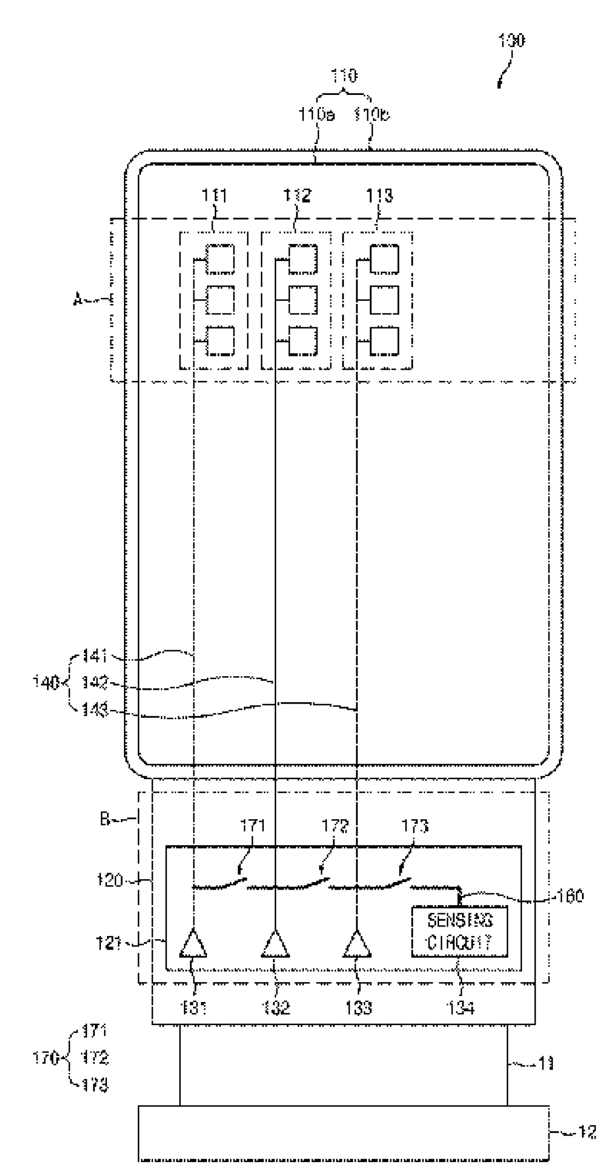
Primary Examiner — Gene W Lee
(74) *Attorney, Agent, or Firm* — The Farrell Law Firm, P.C.

(57) **ABSTRACT**

An electronic device is provided. The electronic device includes a display panel on which a plurality of pixels are arranged, first group lines providing a source voltage to each of the plurality of pixels, a display driver integrated circuit that includes a plurality of source amplifiers electrically connected with the first group lines and providing the source voltage to each of the plurality of pixels, at least one sensing line crossing the first group lines, and first group switches disposed on the at least one sensing line, and a sensing circuit electrically connected with one end of the at least one sensing line to check a crack in at least a partial region of the electronic device. The display driver integrated circuit receives a specified signal for the electronic device to enter a sense mode, applies a first voltage to the other end of the
(Continued)



at least one sensing line that is distinguished from the one end of the at least one sensing line, in response to the received specified signal, turns on the first group switches such that the at least one sensing line is short-circuited from the other end of the at least one sensing line to the sensing circuit, obtains a second voltage sensed by the sensing circuit electrically connected with the one end of the at least one sensing line, and checks information regarding the crack in the at least partial region of the electronic device based on a difference between the first voltage and the second voltage. In addition to the above, various embodiments identified through the specification are possible.

15 Claims, 12 Drawing Sheets

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CPC *G09G 2310/0275* (2013.01); *G09G 2310/0291* (2013.01); *G09G 2310/0297* (2013.01); *G09G 2330/021* (2013.01); *G09G 2330/12* (2013.01)

(58) **Field of Classification Search**
CPC ... G09G 2310/0275; G09G 2310/0291; G09G 2310/0297; G09G 2330/021; G09G 2330/12
See application file for complete search history.

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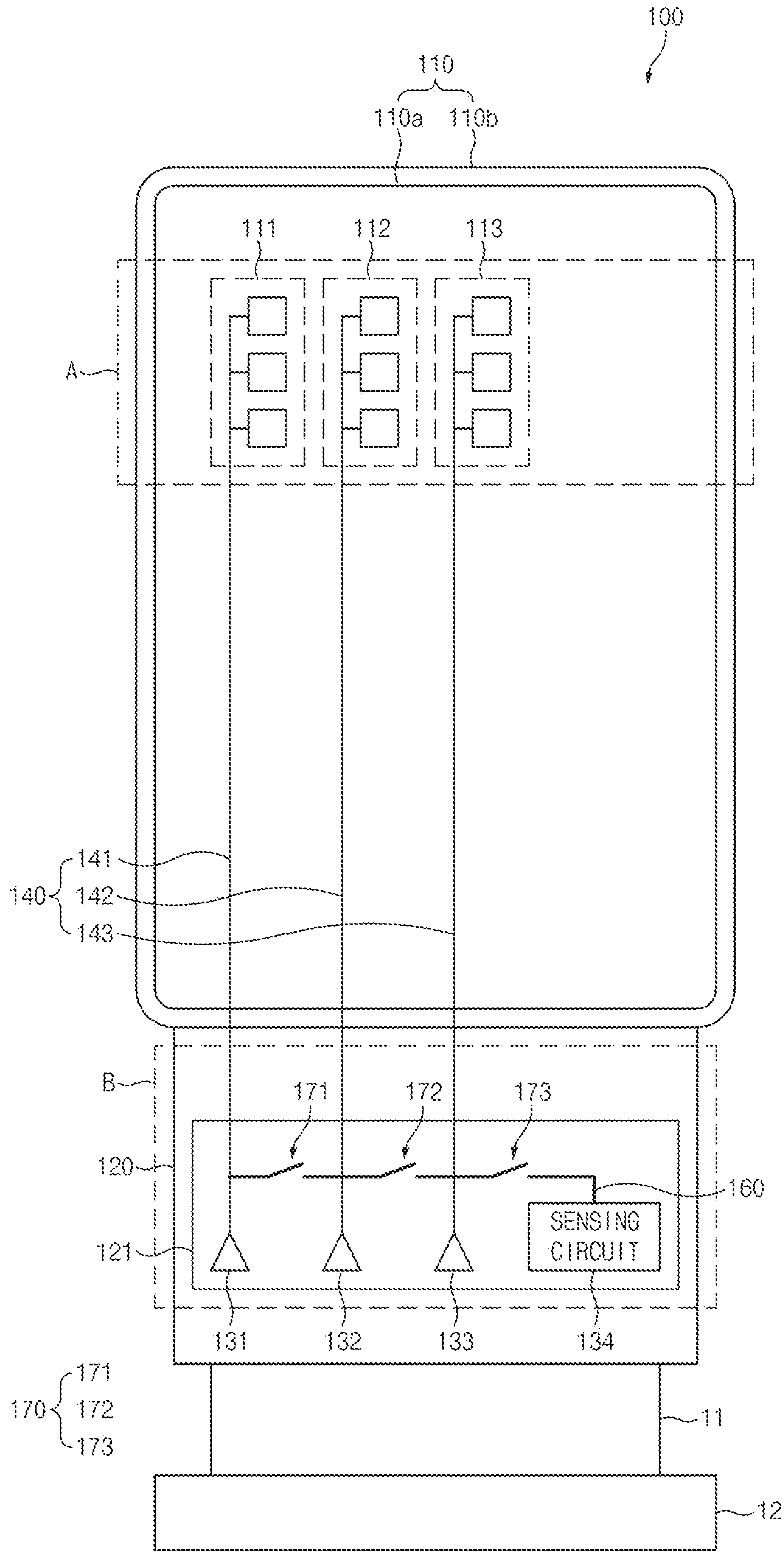
100
110
110a
110b
111
112
113
A
141
140
142
143
B
171
172
173
120
160
121
SENSING CIRCUIT
131
132
133
134
171
170
172
173
11
12

FIG.1

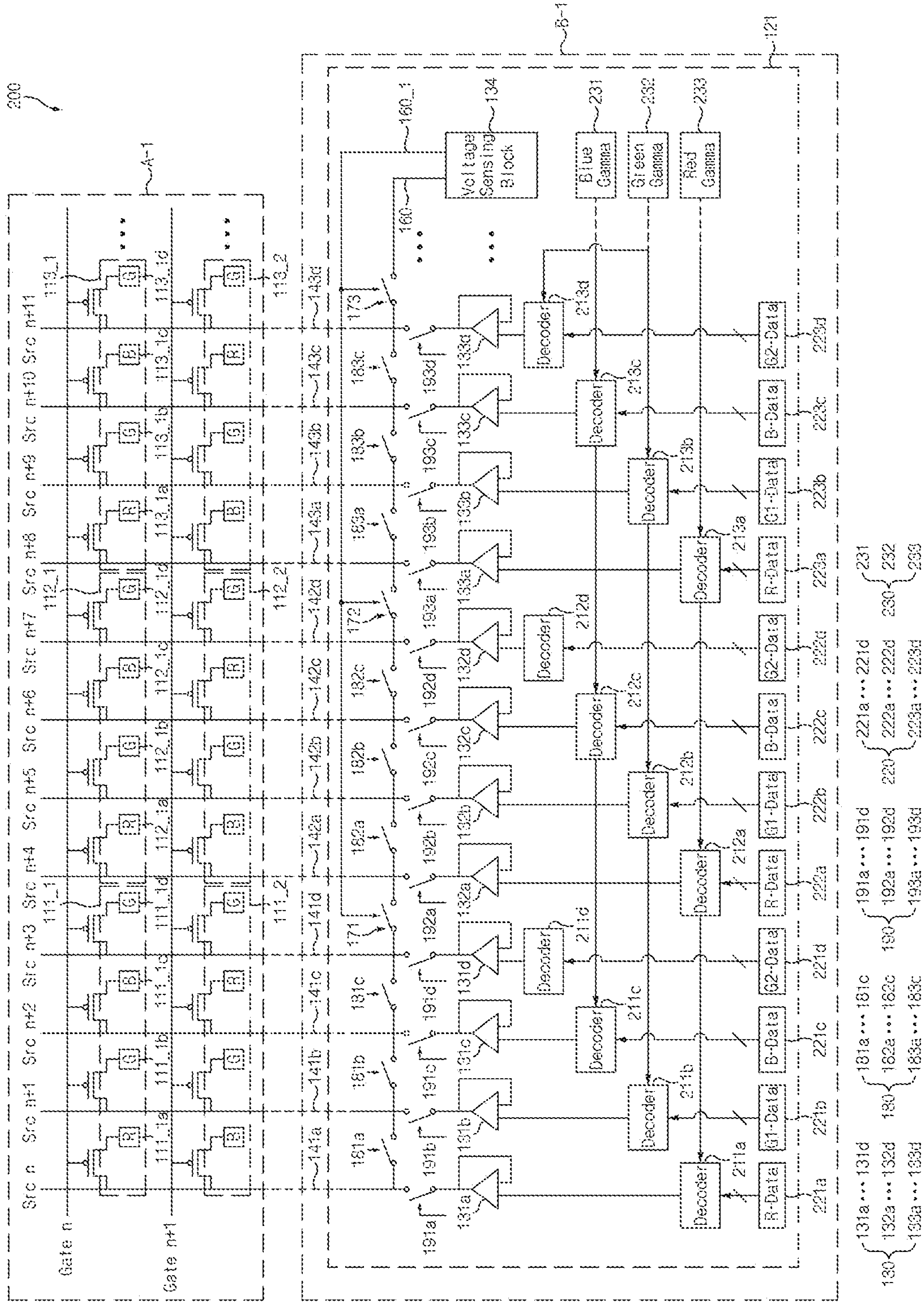
200
A-1
B-1
121
Gate n
Gate n+1
Src n
Src n+1
Src n+2
Src n+3
Src n+4
Src n+5
Src n+6
Src n+7
Src n+8
Src n+9
Src n+10
Src n+11
Voltage Sensing Block
134
160
160_1
Blue Gamma
Green Gamma
Red Gamma
231
232
233
Decoder
R-Data
G1-Data
B-Data
G2-Data
130
180
190
220
230

FIG. 2

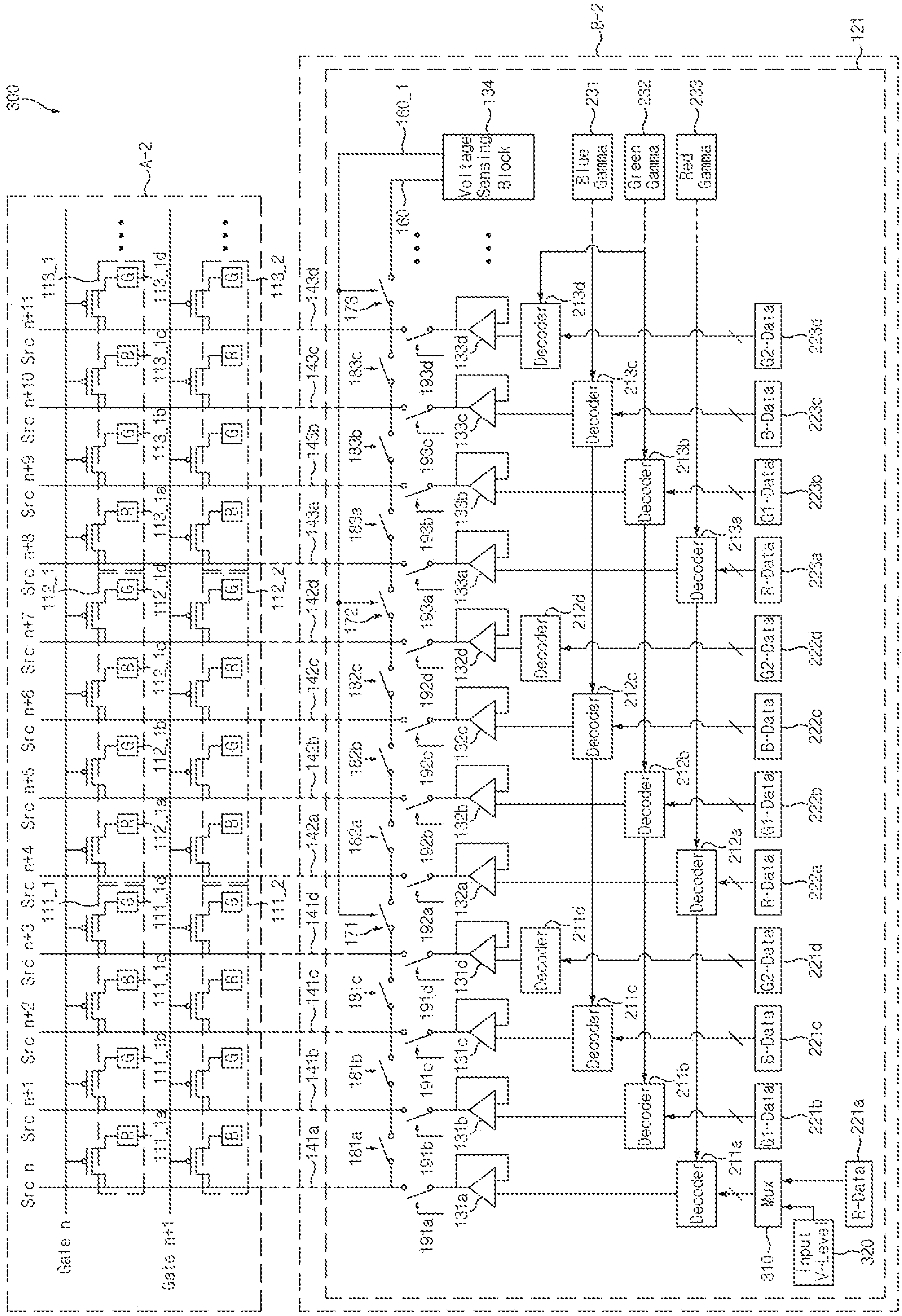
300
A-2
B-2
121
Voltage Sensing Block
134
160
160_1
Blue Gamma
Green Gamma
Red Gamma
231
232
233
Decoder
Mux
310
Input V-Level
320
R-Data
G1-Data
B-Data
G2-Data
221a
221b
221c
221d
222a
222b
222c
222d
223a
223b
223c
223d
Gate n
Gate n+1
Src n
Src n+1
Src n+2
Src n+3
Src n+4
Src n+5
Src n+6
Src n+7
Src n+8
Src n+9
Src n+10
Src n+11

FIG. 3

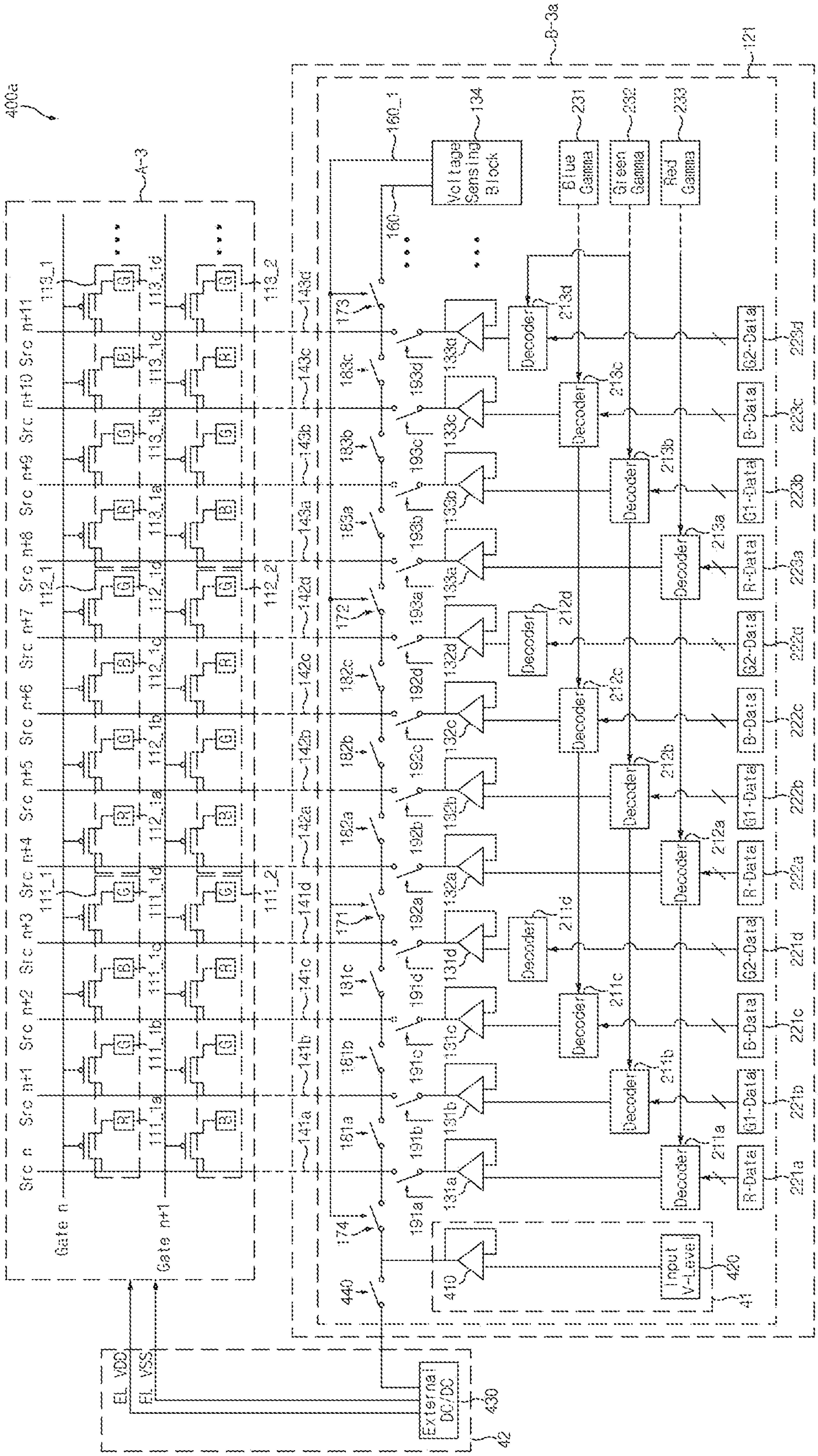
400a
A-3
B-3a
121
Voltage Sensing Block
Blue Gamma
Green Gamma
Red Gamma
Decoder
R-Data
G1-Data
B-Data
G2-Data
Input V-Level
External DC/DC
EL VDD
EL VSS
Gate n
Gate n+1
Src n
Src n+1
Src n+2
Src n+3
Src n+4
Src n+5
Src n+6
Src n+7
Src n+8
Src n+9
Src n+10
Src n+11
42
41
430
440
410
420

FIG. 4A

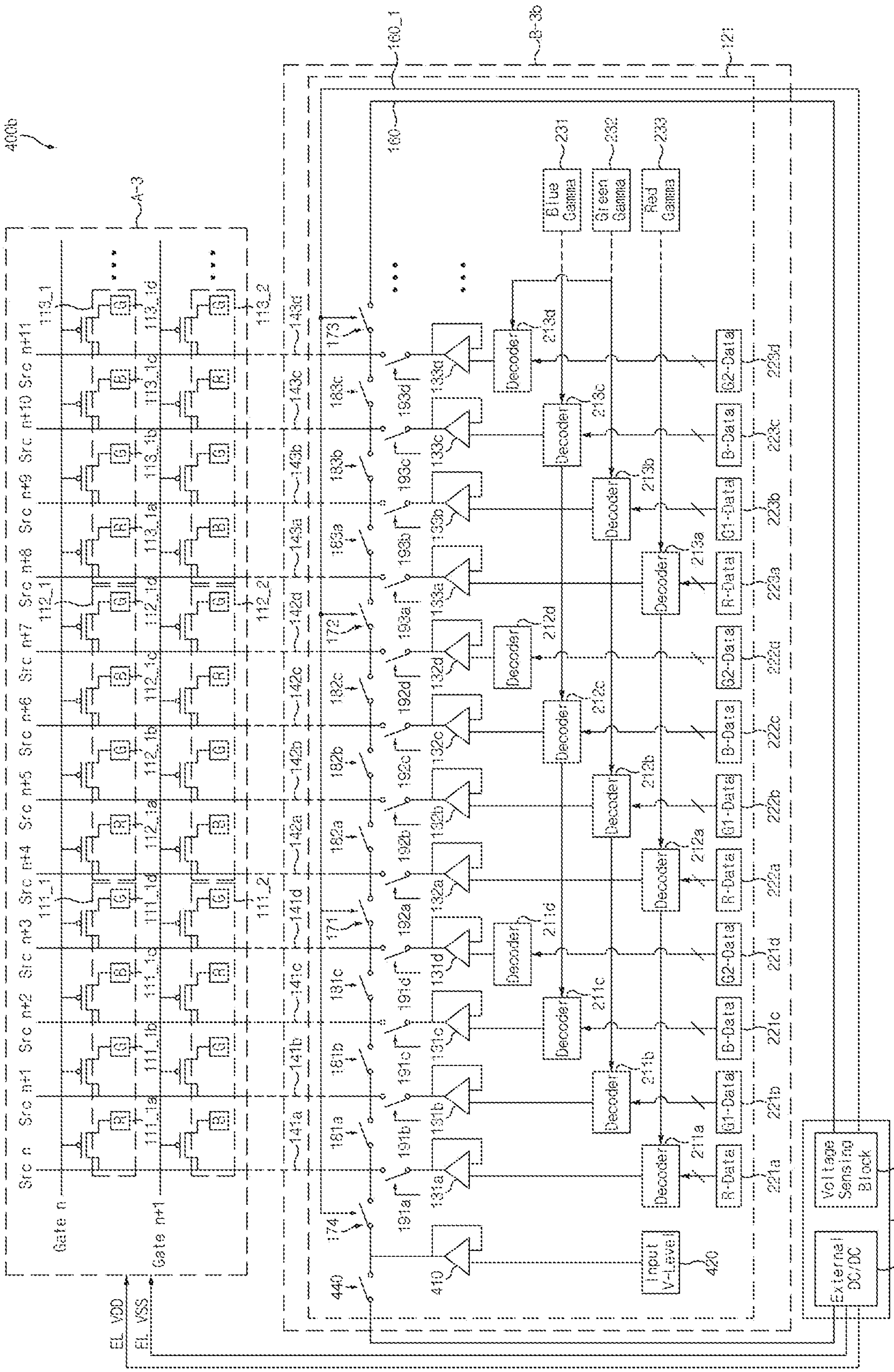
400b
A-3
B-3b
160_1
121
160
Src n
Src n+1
Src n+2
Src n+3
Src n+4
Src n+5
Src n+6
Src n+7
Src n+8
Src n+9
Src n+10
Src n+11
Gate n
Gate n+1
EL VDD
EL VSS
Blue Gamma
Green Gamma
Red Gamma
231
232
233
Decoder
R-Data
G1-Data
B-Data
G2-Data
Input V-Level
420
410
440
Voltage Sensing Block
134
External DC/DC
430
460

FIG. 4B

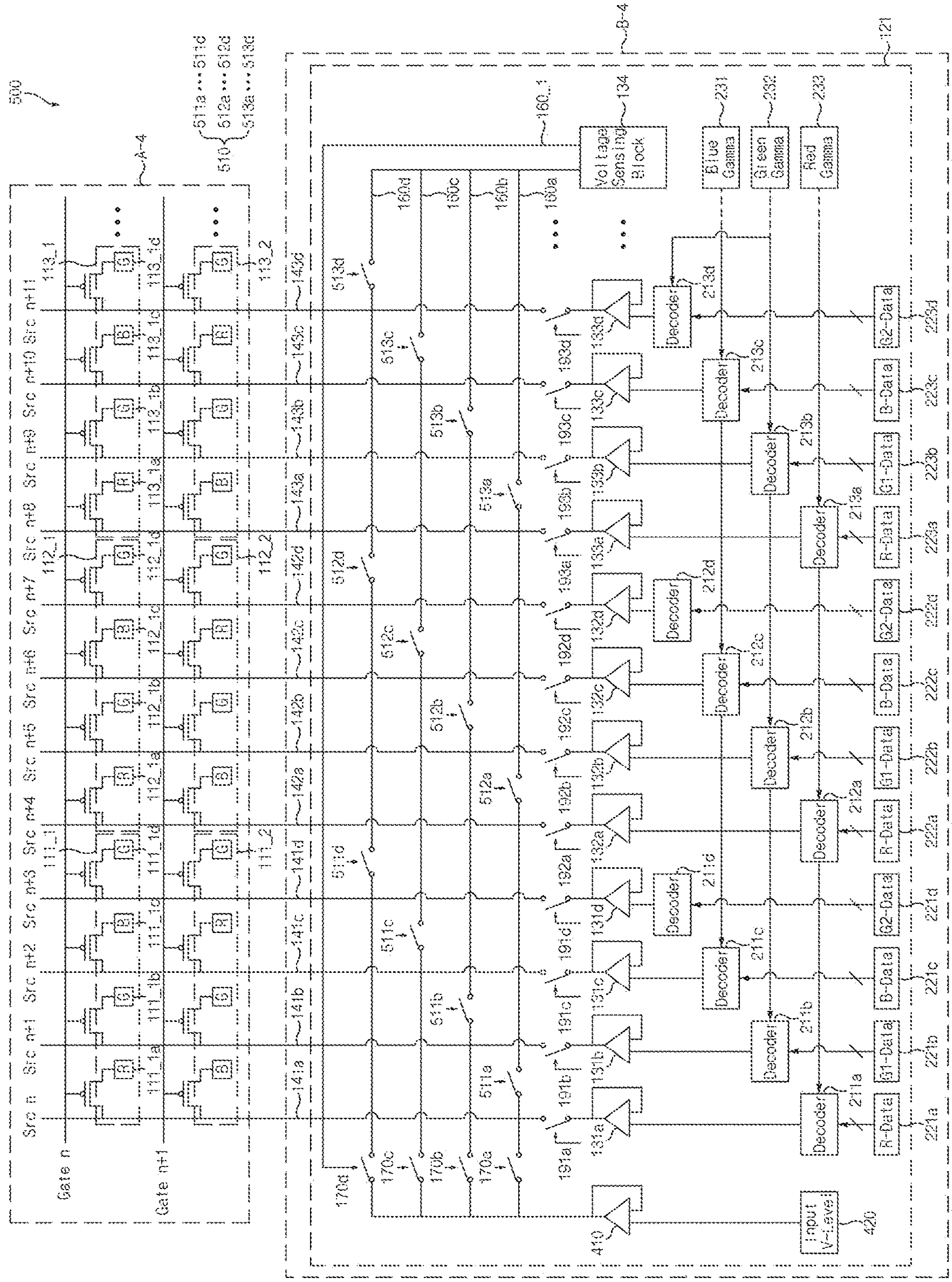
500
A-4
B-4
121
510
511a ••• 511d
512a ••• 512d
513a ••• 513d
Gate n
Gate n+1
Src n
Src n+1
Src n+2
Src n+3
Src n+4
Src n+5
Src n+6
Src n+7
Src n+8
Src n+9
Src n+10
Src n+11
Voltage Sensing Block
134
160_1
Blue Gamma
231
Green Gamma
232
Red Gamma
233
Decoder
R-Data
G1-Data
B-Data
G2-Data
Input V-Level
420
410

FIG.5

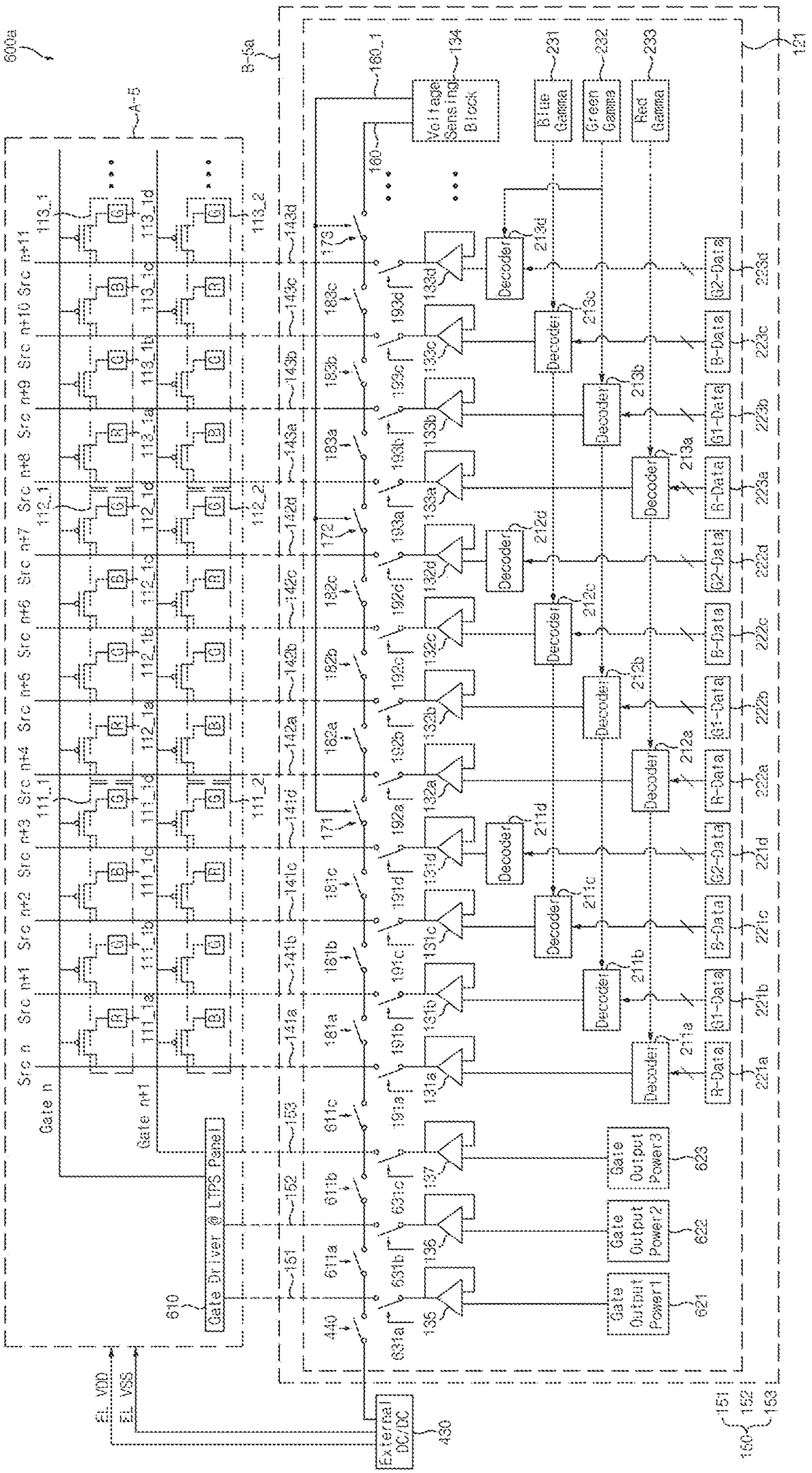
600a
A-5
B-5a
121
Voltage Sensing Block
Blue Gamma
Green Gamma
Red Gamma
Gate Driver @ LTPS Panel
Gate Output Power1
Gate Output Power2
Gate Output Power3
External DC/DC
EL VDD
EL VSS
Decoder
R-Data
G1-Data
B-Data
G2-Data

FIG. 6A

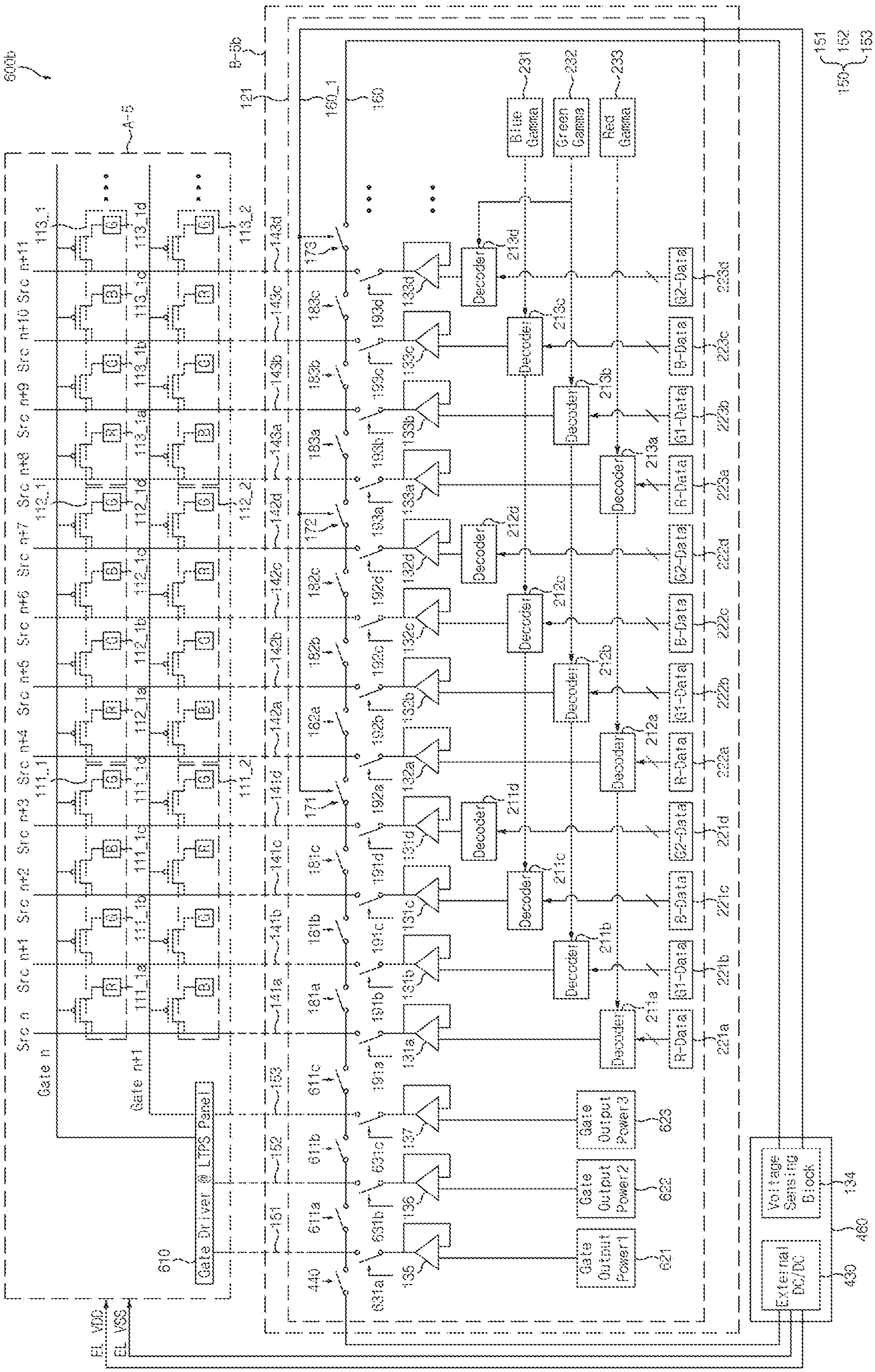
600b
A-5
B-5b
121
160_1
160
Gate Driver @ LTPS Panel
610
Gate n
Gate n+1
Src n
Src n+1
Src n+2
Src n+3
Src n+4
Src n+5
Src n+6
Src n+7
Src n+8
Src n+9
Src n+10
Src n+11
Blue Gamma
Green Gamma
Red Gamma
231
232
233
Gate Output Power1
Gate Output Power2
Gate Output Power3
621
622
623
Voltage Sensing Block
134
External DC/DC
430
460
150
151
152
153
EL VDD
EL VSS
R-Data
G1-Data
B-Data
G2-Data
Decoder

FIG.6B

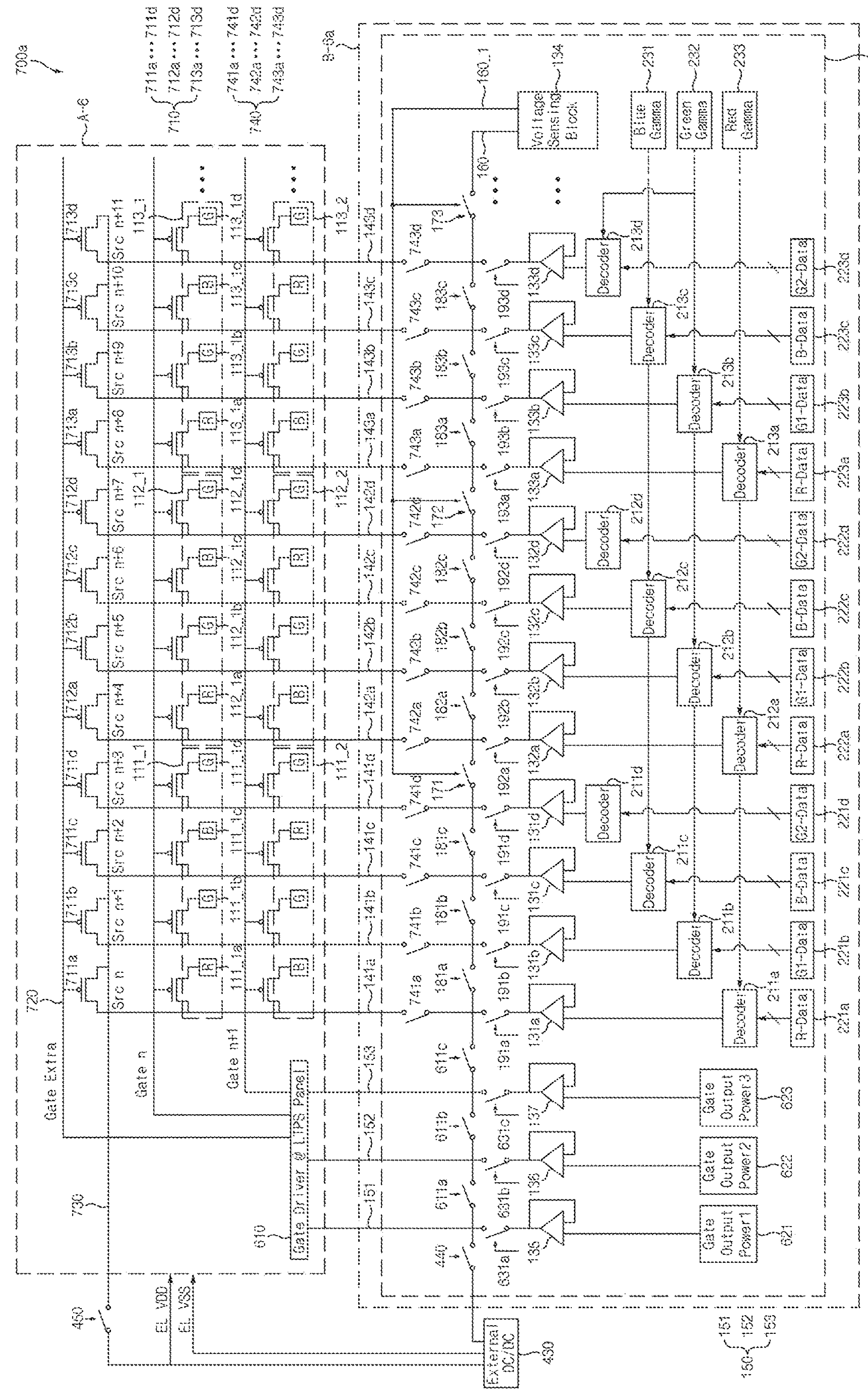
700a
A-6
B-6a
121
710
711a ··· 711d
712a ··· 712d
713a ··· 713d
740
741a ··· 741d
742a ··· 742d
743a ··· 743d
720
730
Gate Extra
Gate n
Gate n+1
Gate Driver @ LTPS Panel
610
Src n
Src n+1
Src n+2
Src n+3
Src n+4
Src n+5
Src n+6
Src n+7
Src n+8
Src n+9
Src n+10
Src n+11
Voltage Sensing Block
134
160
160_1
Blue Gamma
Green Gamma
Red Gamma
231
232
233
Decoder
R-Data
G1-Data
B-Data
G2-Data
Gate Output Power1
Gate Output Power2
Gate Output Power3
621
622
623
External DC/DC
430
440
450
EL VDD
EL VSS
150
151
152
153

FIG. 7A

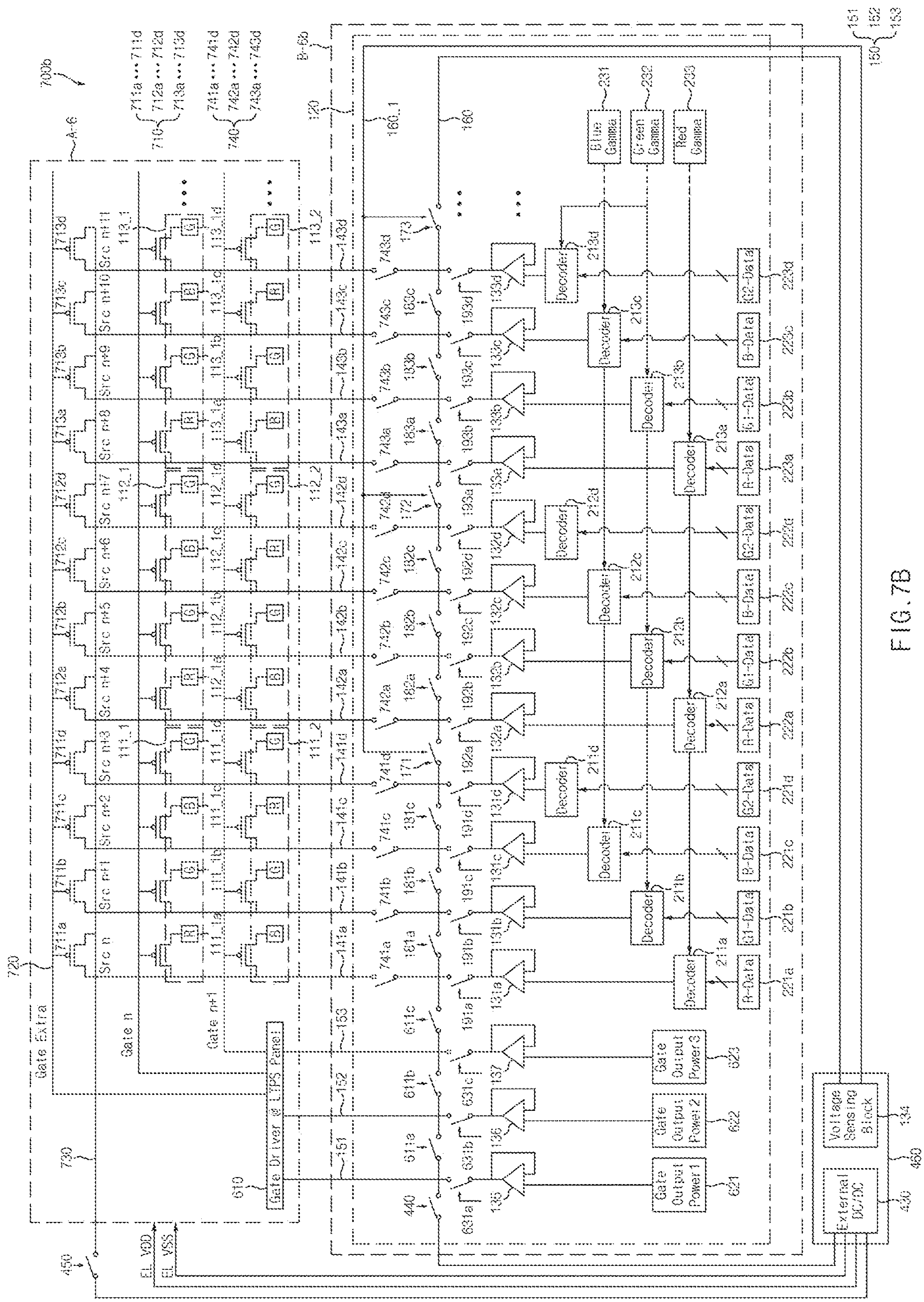
Gate Driver @ LTPS Panel
Gate Extra
Gate n
Gate n+1
EL VDD
EL VSS
Blue Gamma
Green Gamma
Red Gamma
Gate Output Power 1
Gate Output Power 2
Gate Output Power 3
Voltage Sensing Block
External DC/DC

FIG. 7B

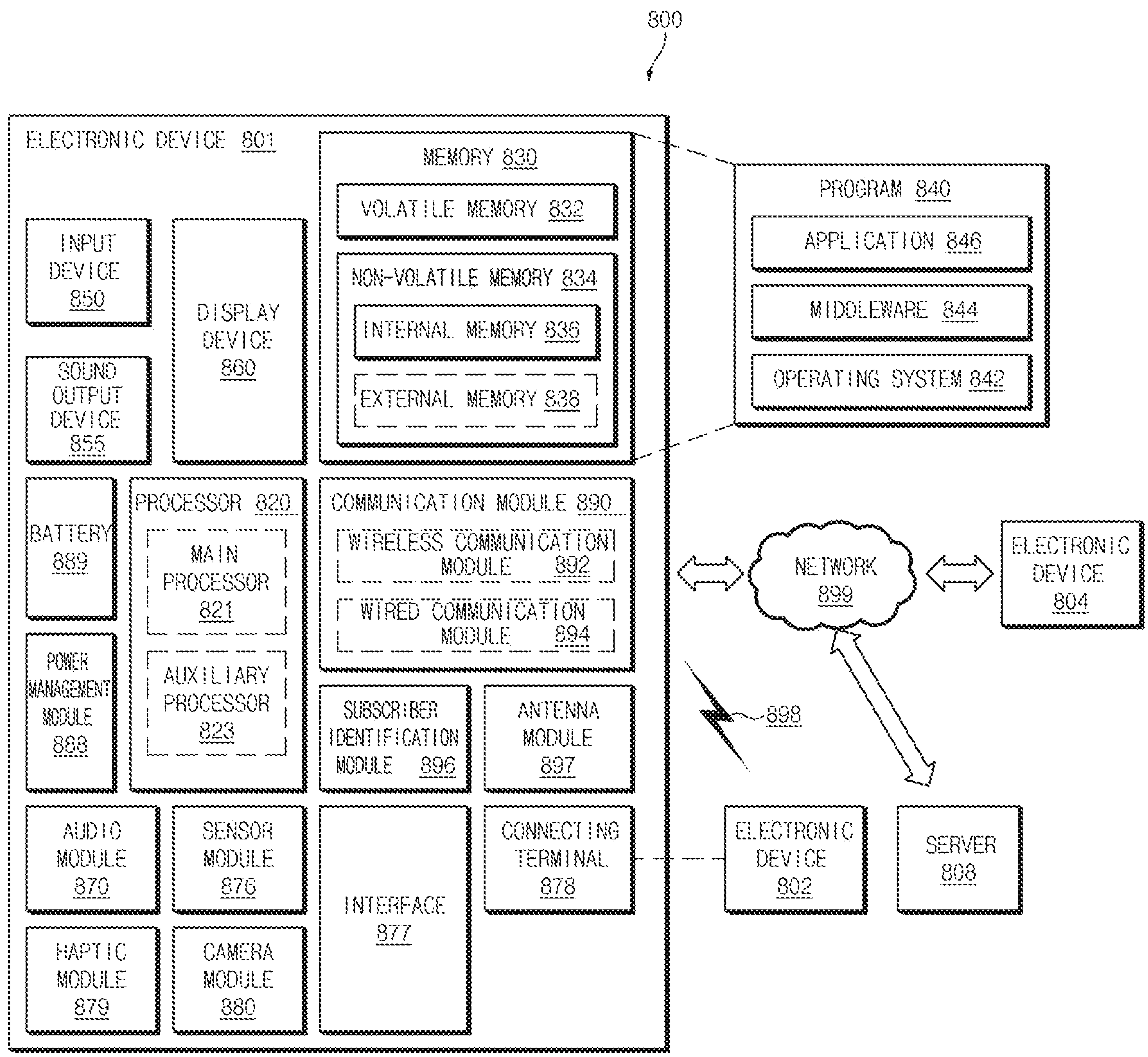
800
ELECTRONIC DEVICE 801
MEMORY 830
VOLATILE MEMORY 832
NON-VOLATILE MEMORY 834
INTERNAL MEMORY 836
EXTERNAL MEMORY 838
PROGRAM 840
APPLICATION 846
MIDDLEWARE 844
OPERATING SYSTEM 842
INPUT DEVICE 850
SOUND OUTPUT DEVICE 855
DISPLAY DEVICE 860
BATTERY 889
POWER MANAGEMENT MODULE 888
PROCESSOR 820
MAIN PROCESSOR 821
AUXILIARY PROCESSOR 823
COMMUNICATION MODULE 890
WIRELESS COMMUNICATION MODULE 892
WIRED COMMUNICATION MODULE 894
SUBSCRIBER IDENTIFICATION MODULE 896
ANTENNA MODULE 897
NETWORK 899
ELECTRONIC DEVICE 804
898
AUDIO MODULE 870
SENSOR MODULE 876
INTERFACE 877
CONNECTING TERMINAL 878
ELECTRONIC DEVICE 802
SERVER 808
HAPTIC MODULE 879
CAMERA MODULE 880

FIG.8

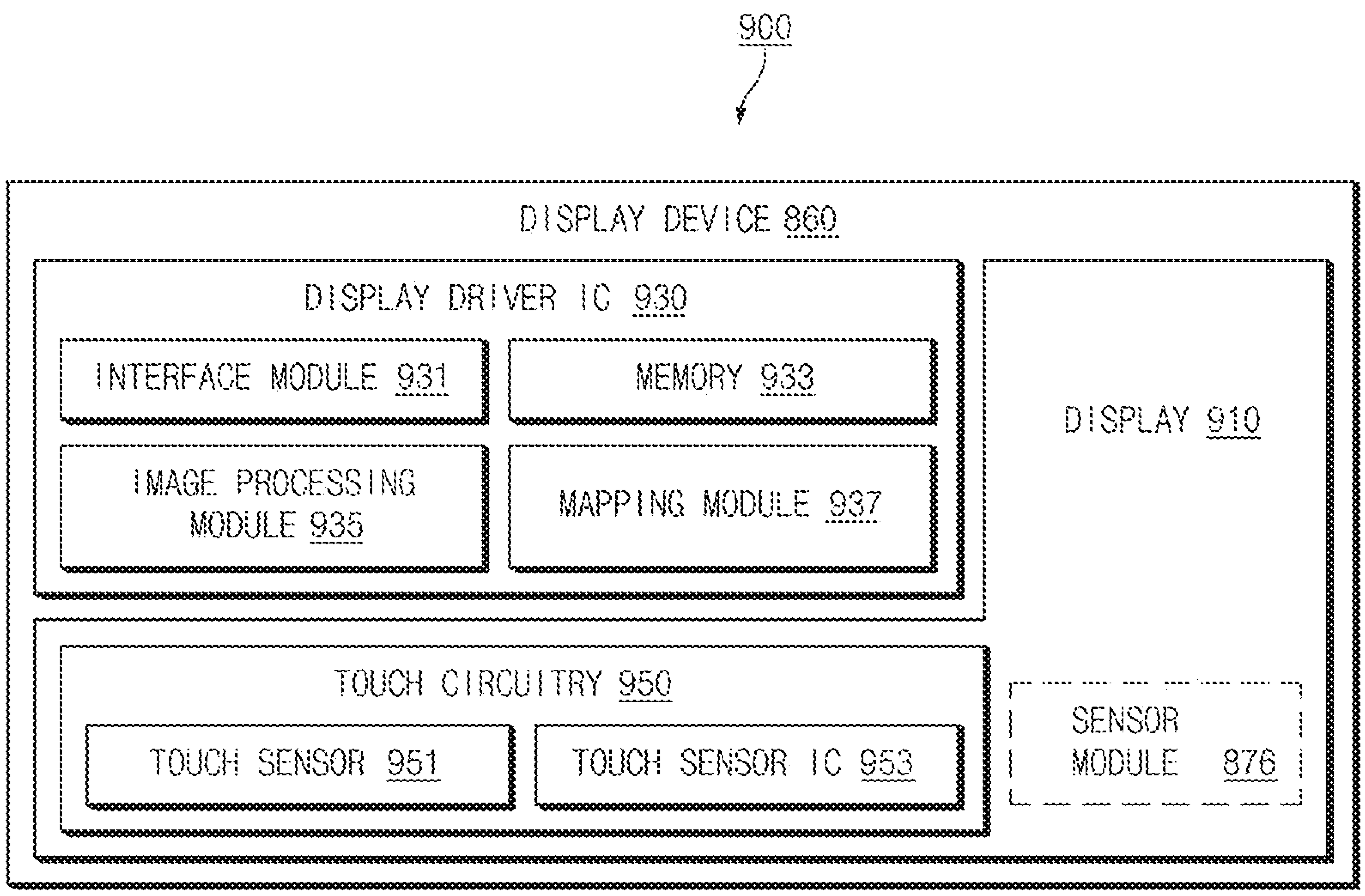
900
DISPLAY DEVICE 860
DISPLAY DRIVER IC 930
INTERFACE MODULE 931
MEMORY 933
IMAGE PROCESSING MODULE 935
MAPPING MODULE 937
DISPLAY 910
TOUCH CIRCUITRY 950
TOUCH SENSOR 951
TOUCH SENSOR IC 953
SENSOR MODULE 876

FIG.9

METHOD FOR CHECKING CRACK IN DISPLAY AND ELECTRONIC DEVICE FOR PERFORMING SAME

PRIORITY

This application is a National Phase Entry of PCT International Application No. PCT/KR2019/006100 which was filed on May 21, 2019, and claims priority to Korean Patent Application No. 10-2018-0057698, which was filed on May 21, 2018, the entire contents of each of which is incorporated herein by reference.

TECHNICAL FIELD

Embodiments disclosed in the present disclosure relate to a method and an electronic device performing the same for checking cracks in a display.

BACKGROUND ART

With the development of information technology (IT), various types of electronic devices including displays, such as a smartphone and a tablet personal computer (PC), have been widely spread.

Since fine elements are elaborately arranged in the display, if the display is shocked in an assembly process of the electronic device, micro cracks may occur in the display. For example, if a crack occurs in a pixel included in the display panel, a specified image may not be output in some region of the display. For another example, if a crack occurs in a source amplifier for transmitting image data to a pixel, the specified image data may not be properly transmitted to the pixel, and an unwanted vertical line may be output on the display.

In order to prevent the above problems in advance, each step of the assembly process of the electronic device may include an operation of checking cracks in the display. For example, if an integrated circuit (IC) of the display is finished, an operation of checking an output voltage or each output terminal, for example, an electrical die sorting (EDS) test may be performed. For another example, when a display module is finished, an operation of checking whether or not an output is abnormal by applying a designated signal to the display module may be performed.

DISCLOSURE OF THE INVENTION

Technical Problem

Even in an operation in which the finished display module is mounted on an electronic device for assembly, cracks may occur inside the display. For example, pressure above a specified level may be generated in some region of the display, or a crack may occur in a part of the display due to other external shocks.

However, when the assembly of the electronic device is completed, it may be difficult to perform an inspection on the interior of the display, for example, a precise inspection such as the EDS test. In this case, the display may be finally checked for defects simply by visual inspection. However, it may be difficult to properly check whether or not the display is defective only by such visual inspection. As described above, the electronic device may be provided to a user without properly checking cracks in the display that may occur in the final assembly step.

Embodiments disclosed in the present disclosure are to provide an electronic device for solving the aforementioned problems and the problems posed in the present disclosure.

Technical Solution

Accordingly, an aspect of the present disclosure is to provide an electronic device including a display panel on which a plurality of pixels are arranged, first group lines providing a source voltage to each of the plurality of pixels, a display driver integrated circuit that includes a plurality of source amplifiers electrically connected with the first group lines and providing the source voltage to each of the plurality of pixels, at least one sensing line crossing the first group lines, and first group switches disposed on the at least one sensing line, and a sensing circuit electrically connected with one end of the at least one sensing line to check a crack in at least a partial region of the electronic device, in which the display driver integrated circuit receives a specified signal for the electronic device to enter a sense mode, applies a first voltage to the other end of the at least one sensing line that is distinguished from the one end of the at least one sensing line, in response to the received specified signal, turns on the first group switches such that the at least one sensing line is short-circuited from the other end of the at least one sensing line to the sensing circuit, obtains a second voltage sensed by the sensing circuit electrically connected with the one end of the at least one sensing line, and checks information regarding the crack in the at least partial region of the electronic device based on a difference between the first voltage and the second voltage.

Another aspect of the present disclosure is to provide a display. The display may include a display panel including a plurality of pixels each including a plurality of sub-pixels, a plurality of source amplifiers electrically connected with the plurality of sub-pixels, first group source switches disposed on an electrical path between output terminals of the plurality of source amplifiers and the plurality of sub-pixels, first group sharing switches selectively connecting the plurality of sub-pixels included in each of the plurality of pixels with each other, first group switches selectively connecting the plurality of pixels with each other, a sensing circuit selectively connected with the plurality of sub pixels or the plurality of source amplifiers through the first group source switches, the first group sharing switches, and the first group switches, and a display driver integrated circuit electrically connected with input terminals of the plurality of source amplifiers and the sensing circuit, in which the display driver integrated circuit may be configured to supply a first voltage to a first source amplifier of the plurality of source amplifiers in a state in which a first source switch corresponding to the first amplifier, at least some of the first group sharing switches, and at least some of the first group switches are turned on, sense a second voltage obtained by transmitting the first voltage to the sensing circuit through the specified first source switch, the at least some of the first group sharing switches, and the at least some of the first group switches by using the sensing circuit, and check information regarding a crack in the display at least based on the sensed second voltage.

Another aspect of the present disclosure is to provide a display. The display may include a display panel that includes a plurality of pixels including a plurality of sub-pixels, one or more source amplifiers electrically connected with the plurality of sub-pixels, a power supply electrically connected with output terminals of the plurality of sub-pixels and the one or more source amplifiers, first group sharing switches selectively connecting the plurality of sub-pixels included in each of the plurality of pixels, first group switches selectively connecting the plurality of pixels with each other, a sensing circuit selectively connected with the plurality of sub-pixels or the one or more source amplifiers through the first group sharing switches and the first group switches, and a display driver integrated circuit electrically connected with input terminals of the one or more source amplifiers and the sensing circuit, in which the display driver integrated circuit may be configured to turn on at least some of the first group sharing switches and at least some of the first group switches, sense a second voltage obtained by transmitting the first voltage supplied from the power supply device to the sensing circuit through the at least some of the first group sharing switches and the at least some of the first group switches, and check information regarding a crack in the display at least based on the sensed second voltage.

Advantageous Effects

According to embodiments disclosed in the present disclosure, an electronic devise may check cracks in a display even in the final assembly step. In this way, a defective rate for an electronic device provided to a user may be reduced. Besides, various effects may be provided that are directly or identified through the present disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** illustrates an internal diagram of an electronic device according to an embodiment.

FIG. **2** illustrates a detailed circuit diagram an electronic device for checking cracks in a connection member and a source amplifier, according to an embodiment.

FIG. **3** illustrates a detailed circuit diagram of an electronic device for checking cracks in a connection member and a source amplifier, according to another embodiment.

FIG. **4***a* illustrates a detailed circuit diagram of an electronic device for checking cracks in a connection member and a source amplifier, according to yet another embodiment.

FIG. **4***b* illustrates a detailed circuit diagram of an electronic device for checking cracks in a connection member and a source amplifier, according to yet another embodiment.

FIG. **5** illustrates a detailed circuit diagram of an electronic device including a plurality of sensing lines, according to an embodiment.

FIG. **6***a* illustrates a detailed circuit diagram of an electronic device for checking cracks in a gate amplifier, according to an embodiment.

FIG. **6***b* illustrates a detailed circuit diagram of an electronic device for checking cracks in a gate amplifier, according to an embodiment.

FIG. **7***a* illustrates a detailed circuit diagram of an electronic device for checking cracks in a display panel, according to an embodiment.

FIG. **7***b* illustrates a detailed circuit diagram of an electronic device for checking cracks in a display panel, according to an embodiment.

FIG. **8** is a block diagram illustrating an electronic device in a network environment according to various embodiments.

FIG. **9** is a block diagram illustrating the display device according to various embodiments.

With respect to the description of the drawings, the same or similar reference signs may be used for the same or similar elements.

MODE FOR CARRYING OUT THE INVENTION

FIG. **1** illustrates an internal diagram of an electronic device according to an embodiment.

Referring to FIG. **1**, an electronic device **100** may include a display panel **110**, a display driver integrated circuit **121**, first group lines **140**, a flexible printed circuit board (FPCB) **11**, and a main printed circuit board (M-PCB) **12**. In an embodiment, the electronic device **100** may include a connection member **120**, and the display driver integrated circuit **121** and the first group lines **140** may be disposed on the connection member **120**. According to various embodiments, the electronic device **100** may further include a component not illustrated in FIG. **1** or may omit a component illustrated in FIG. **1**. For example, the electronic device **100** may further include a gate amplifier (not illustrated) for providing a gate voltage to pixels **111**, **112**, and **113** included in the display panel **110**. For another example, the electronic device **100** may omit the FPCB **11**.

The display panel **110** may include an active region **110***a* and an inactive region **110***b*. According to an embodiment, the active region **110***a* may include a plurality of pixels **111**, **112**, and **113** arranged in a grid, and a specified image may be output by using the plurality of pixels **111**, **112**, and **113**. In an embodiment, the inactive region **110***b* may be located at the outer periphery of the active region **110***a*. The inactive region **110***b* may be understood as a region on the display panel **110** in which the pixels **111**, **112**, and **113** are not arranged.

According to an embodiment, the plurality of pixels **111**, **112**, and **113** may include a first group pixel **111**, a second group pixel **117**, and a third group pixel **113**, which are divided based on connected source amplifiers **131**, **132**, and **133**. The first group pixel **111** may receive a source voltage from the first source amplifier **131**, and the second group pixel **112** may receive a source voltage from the second source amplifier **132**. The third group pixel **113** may receive a source voltage from the third source amplifier **133**.

The connection member **120** may extend from one end of the display panel **110** to physically connect the display panel **110** with the display driver integrated circuit **121**. According to an embodiment, the connection member **120** may include a board, for example, a polyimide (PI) board. According to another embodiment, the connection member **120** may include a board and a bendable film material. Accordingly, at least a portion of the connection member **120** may be bent toward the back surface of the display panel **110**.

According to an embodiment, conductive wires for connecting respective components may be disposed on the connection member **120**. For example, the first group lines **140** for providing the source voltage to the plurality of pixels **111**, **112**, and **113** may be disposed on the connection member **120**.

The display driver integrated circuit **121** may drive the display panel **110** to output a specified image to the display panel **110** by providing, to the display panel **110**, voltages of a specified magnitude, for example, the source voltage or a gate voltage. According to an embodiment, the display driver integrated circuit **121** may include a plurality of source amplifiers **131**, **132**, and **133**, a sensing circuit **134**, a sensing line **160**, and first group switches **170**. According to various embodiments, the display driver integrated circuit **121** may further include a component not illustrated in FIG.

1, for example, a gate amplifier, a gamma circuit, or a controller. According to various embodiments, the display driver integrated circuit **121** may not include the sensing circuit **134**, unlike that illustrated in FIG. **1**. For example unlike that illustrated in FIG. **1**, the sensing circuit **134** may be disposed outside the display driver integrated circuit **121**, for example, on the connection member **120**, the FPCB **11**, or the M-PCB **12**.

According to an embodiment, if the electronic device **100** is not in a sense mode, the plurality of source amplifiers **131**, **132**, and **133** may provide, a specified voltage, for example, the source voltage, to the pixels **111**, **112**, and **113** through the first group lines **140**. For example, the first source amplifier **131** may provide the source voltage to pixels included in the first group pixel **111** through a first line **141**, and the second source amplifier **132** may provide the source voltage to pixels included in the second group pixel **112** through a second line **142**. The sense mode may be, for example, an operating state of the electronic device **100** for checking whether or not a crack occurs in at least some region of the electronic device **100** after assembly of the electronic device **100**.

According to an embodiment, if the electronic device **100** in the sense mode, the plurality of source amplifiers **131**, **132**, and **133** may provide a specified voltage, for example, a first voltage, to the sensing line **160** through at least one of the first group lines **140**. For example, the first source amplifier **131** may provide the first voltage to the sensing line **160** through the first line **141**. According to an embodiment, the first voltage may be provided by another component, for example, an external power supply not illustrated in FIG. **1**. In this case, the output of the plurality of source amplifiers **131**, **132**, and **133** may be limited. For example, the plurality of source amplifiers **131**, **132**, and **133** may not provide the first voltage to the first group lines **140**.

In the present specification, the first voltage may be understood as a voltage applied to the other end of the sensing line **160** that is distinguished from one end of the sensing line **160** connected with the sensing circuit **134**. The second voltage distinguished from the first voltage may be understood as a voltage sensed by the sensing circuit **134** by transmitting the first voltage from the other end of the sensing line **160** to the one end thereof through the sensing line **160**.

According to an embodiment, the sensing circuit **134** may be connected with one end of the sensing line **160** to check a crack in at least some region of the electronic device **100**. The sensing circuit **134** may compare the signal applied to the other end of the sensing line **160**, for example, the first voltage with the signal obtained by the sensing circuit **134**, for example, the second voltage to check the crack in at least some region of the electronic device **100**. For example, the sensing circuit **134** may check whether or not the region on which the sensing line **160** is disposed is cracked. For another example, the sensing circuit **134** may check whether or not the source amplifiers **131**, **132**, and **133** connected with the sensing line **160** are cracked. For yet another example, the sensing circuit **134** may check whether or not the plurality of pixels **111**, **112**, and **113** connected with the sensing line **160** are cracked. In the present specification, the sensing circuit **134** may also be referred to as a voltage sensing block.

According to an embodiment, the sensing line **160** may be at least one conductive line crossing the first group lines **140**. According to an embodiment, one end of the sensing line **160** may be electrically connected with the sensing circuit **134**. A specified signal, for example, the first voltage, may be applied to the other end of the sensing line **160** that is distinguished from one end thereof. The sensing line **160** may transmit the first voltage applied from the other end to the sensing circuit **134** connected to the one end. The voltage obtained by the sensing circuit **134** by transmitting the first voltage may be referred to as a second voltage that is distinguished from the first voltage.

According to an embodiment, the other end of the sensing line **160** may be electrically connected with the output terminal of at least one of the source amplifier **131**, **132**, or **133** as illustrated in FIG. **1**. According to another embodiment, the other end of the sensing line **160** may be electrically connected with a specified external power supply not illustrated in FIG. **1** or an output terminal of a separate source amplifier.

According to an embodiment, the first group switches **170** may be disposed on the sensing line **160**. According to an embodiment, the first group switches **170** may be disposed between the first group lines **140** electrically connected with each pixel, or may be disposed between at least one of the first group lines **140** and the sensing circuit **134**. According to an embodiment, the first group switches **170** may be turned on or off based on the control of the sensing circuit **134**.

According to an embodiment, if the electronic device **100** is in the sense mode, at least some of the first group switches **170** may be turned on, and at least a part of the sensing line **160** may be short-circuited. If the electronic device **100** is not in the sense mode, all of the first group switches **170** may be turned off and the sensing line **160** may be opened.

According to an embodiment, the first group lines **140** may be a set of conductive lines extending from each of the source amplifiers **131**, **132**, and **133** to the plurality of pixels **111**, **112**, and **113**. In an embodiment, the first group lines **140** may be disposed on the connection member **120**. According to various embodiments, the first group lines **140** may electrically connect the plurality of pixels **111**, **112**, and **113** with the source ampifiers **131**, **132**, and **133**. In this way, specified electrical signals, for example, a voltage or a current may be transmitted to each other.

According, to an embodiment, the FPCB **11** may be connected with the connection member **120** and the M-PCB **12**. The FPCB **11** may be implemented with a bendable material, for example, a film. In an embodiment, when the FPCB **11** is bent toward the back surface of the connection member **120** or the display panel **110**, the M-PCB **12** may be disposed on the back surface side of the connection member **120** or the display panel **110**.

In an embodiment, at least one electronic component or conductive wires electrically connecting the at least one electronic component with each other may be disposed on the FPCB **11**. For example, unlike that illustrated in FIG. **1**, on the FPCB **11**, the sensing circuit **134** may be disposed and conductive wires electrically connected with the sensing circuit **134**, for example, at least some of the sensing line **160** may be disposed.

According to an embodiment, the M-PCB **12** may be connected with the connection member **120** through the FPCB **11**. In another embodiment, the M-PCB **12** may be directly connected with the connection member **120**, unlike that illustrated in FIG. **1**. According to an embodiment, on the M-PCB **12**, there may be arranged various electronic components included in the electronic device **100** and conductive wires electrically connecting the electronic components. Examples of the electronic components may include a processor, a memory, an external power supply, or the sensing circuit **134** (unlike that illustrated in FIG. **1**).

In the present disclosure, components having the same reference numerals as those included in the electronic device **100** illustrated in FIG. **1** may be the same as those described in FIG. **1**.

FIG. **2** illustrates a detailed circuit diagram of an electronic device for checking cracks in a connection member and a source amplifier, according to an embodiment.

Referring to FIG. **2**, an electronic device **200** may include a region A-**1** and a region B-**1**. The region A-**1** may be understood as an enlarged view of the region A illustrated in FIG. **1**, and the region B-**1** may be understood as an enlarged view of the region B illustrated in FIG. **1**. In other words, the region A-**1** may represent a port a region of the display panel **110**, and the region B-**1** may represent a portion of the connection member **120** on which the display driver integrated circuit **121** disposed. In the description of FIG. **2**, content that has been already shown in the description of FIG. **1** may be omitted.

Referring to the A-**1** region, the display panel **110** may include a plurality of pixels **111_1**, **111_2**, **112_1**, **112_2**, **113_1**, and **113_2**. According to an embodiment, each of the plurality of pixels **111_1**, **111_2**, **112_1**, **112_2**, **113_1**, and **113_2** may include a plurality of sub-pixels. For example, each of the pixels, for example, the first pixel **111** may include one red sub-pixel **111_1**_a_, two green sub-pixels **111_1**_b_ and **111_1**_d_, and one blue sub-pixel **111_1**_c_, as illustrated in FIG. **2**. For another example, each of the pixels may include one red sub-pixel, one green sub-pixel, and one blue sub-pixel, unlike illustrated in FIG. **2**. For yet another example, each of the pixels may include one red sub-pixel, one green sub-pixel, one blue sub-pixel, and one white blue sub-pixel unlike that illustrated in FIG. **2**.

According to an embodiment, each of the sub-pixels (e.g., the first red sub-pixel **111_1**_a_) may be electrically connected with the first group lines **140**. The first group lines **140** may include a plurality of lines **141**_a_, **141**_b_, **141**_c_, **141**_d_, **142**_a_, **142**_b_, **142**_c_, **142**_d_, **143**_a_, **143**_b_, and **143**_d_. The sub-pixels may receive a source voltage from the source amplifiers **130** through the first group lines.

Referring to the B-**1** region, the first group lines **140** and the display driver integrated circuit **121** may be disposed on the connection member **120**. In an embodiment, the display driver integrated circuit **121** may include the plurality of source amplifiers **130**, first group source switches **190**, a decoder group **210**, a gamma circuit **230**, and the sensing circuit **134**. The sensing line **160**, first group sharing switches **180**, the first group switches **170**, and a control line **160_1** may be disposed in the display driver integrated circuit **121**.

According to various embodiments, the connection member **120** or the display driver integrated circuit **121** is not limited to that illustrated in FIG. **2**. For example, the display driver integrated circuit **121** may further include a gate amplifier, and the connection member **120** may further include second group lines connected with the gate amplifier. For another example, the display driver integrated circuit **121** may further include a controller that controls the configuration of the display driver integrated circuit **121**. For yet another example, the sensing circuit **134** may not be included in the display driver integrated circuit **121** and may be disposed on the FPCB **11** or the M-PCB **12** illustrated in FIG.

According to an embodiment, the first group sharing switches **180** and the first group switches **170** may be disposed between the first group lines **140**. According to an embodiment, the first group switches **170** may be disposed between any one of the first group lines **140** and the sensing circuit **134**.

In an embodiment, the first group sharing switches **180** may be disposed between lines for sub-pixels included in one pixel of the first group lines **140**. For example, the first group sharing switches **180** may be disposed among the first line **141**_a_, the second line **141**_b_, the third line **141**_c_, and the fourth line **141**_d_ for the sub-pixels **111_1**_a_, **111_1**_b_, **111_1**_c_, and **111_1**_d_ included in the first pixel **111_1**. In an embodiment, sub-pixels included in one pixel may be selectively connected through the first group sharing switches **180**. For example, the first red sub-pixel **111_1**_a_ and the first green sub-pixel **111_1**_b_ may be selectively connected through a first sharing switch **181**_a_ along the first line **141**_a_ and the second line **141**_b_.

In an embodiment, the first group switches **170** may be disposed between lines positioned at a boundary between different pixels. For example, the first group switches **170** may be disposed between the fourth line **141**_d_ and the fifth line **142**_a_ positioned between the first pixel **111_1** and the second pixel **112-1**.

According to an embodiment, if the electronic device **200** is not in the sense mode, the first group sharing switches **180** may share some of the outputs of the source amplifiers **130** among a plurality of sub-pixels included in one pixel. For example, the first sharing switch **181**_a_ may be turned on to share the output of a first red source amplifier **131**_a_ between the first red sub-pixel **111_1a** and the first green sub-pixel **111_1**_b_. For another example, the first sharing switch **181**_a_ and a second sharing switch **181**_b_ may be turned on to share the output of the first red source amplifier **131**_a_ among the first red sub-pixel **111_1**_a_, the first green sub-pixel **111_1**_b_, and the first blue sub-pixel **111_1**_c_. In this case, since the electronic device **200** may inactivate at least some of the source amplifiers **130**, power consumption may be reduced.

According to an embodiment, if the electronic device **200** is in the sense mode, the first group sharing switches **180** and the first group switches **170** may short-circuit at least a part of the sensing line **160**. For example, if the electronic device **200** is in the sense mode, the first group sharing, switches **180** and the first group switches **170** may be all turned on. In this case, the sensing line **160** may be short-circuited from the first line **141**_a_ to the sensing circuit **134**, and a specified signal, for example, the first voltage, applied from the other end of the sensing line **160**, for example, the first line **141**_a_, may be transmitted to one end of the sensing line **160**, for example, the sensing circuit **134**.

According to an embodiment, the control line **160_1** may be a signal line for controlling the first group switches **170**. In an embodiment, the sensing circuit **134** may turn on or off the first group switches **170** through the control line **160_1**. For example, if the electronic device **200** is in the sense mode, the sensing circuit **134** may turn on at least some of the first group switches **170** through the control line **160_1**. For another example, when the electronic device **200** is not in the sense mode, the sensing, circuit **134** may turn off the first group switches **170** through the control line **160_1**. If the first group switches **170** are turned off, at least a part of the sensing line **160** may be opened, and the output of the source amplifier may not be shared between different pixels.

According, to an embodiment, the plurality of source amplifiers **130** may amplify an electrical signal, for example, a voltage input from the decoder group **210** by a specified level and output the amplified voltage. According to an embodiment, when the electronic device **200** is not in the sense mode, the source amplifiers **130** may provide the output voltage to a plurality of pixels or sub-pixels. According to an embodiment, if the electronic device **200** is in the sense mode, the source amplifiers **130** may apply the output voltage to the sensing line **160**.

According to an embodiment, first group source switches **190** may be disposed at the respective output terminals of the source amplifiers **130**. The first group source switches **190** may activate or inactivate the output of each of the source amplifiers **130**. For example, if the electronic device **200** is in the sense mode, a first source switch **191***a* among the first group source switches **190** may be turned on and the remaining source switches may be turned off. In this case, the output of the first source amplifier **131***a*, for example, the first voltage may be applied to the sensing line **160**. The first voltage may be transmitted to the sensing circuit **134** through the sensing line **160**. For another example, if the electronic device **200** is in the sense mode, the first group source switches **190** may be sequentially turned on or off one by one according to a specified time interval. In this case, the outputs of the plurality of source amplifiers **130** may be sequentially applied to the sensing line **160** one by one according to a specified time interval.

According to an embodiment, the decoder group **210** may combine image data **220** and grayscale voltage data received from the gamma circuit **230**. The image data **220** may be provided, for example, from a controller. According to an embodiment, the combined data may be converted from a digital signal to an analog signal, for example, a voltage. The decoder group **210** may provide the converted analog signal to the source amplifiers **130**.

According to an embodiment, the gamma circuit **230** may include a red gamma circuit **233**, a green gamma circuit **232**, and a blue gamma circuit **231**, which are classified according to characteristics of sub-pixels. The gamma circuit **230** may generate grayscale voltage data for determining the grayscale of each sub-pixel. The generated grayscale voltage data may be converted into an analog signal, for example, a grayscale voltage, and combined with the image data **220**.

According to an embodiment, the electronic device **200** may enter the sense mode based on a specified signal. The specified signal may be, for example, a specified input from a user or a signal applied from an external device. In an embodiment, the specified signal may be transmitted to the display driver integrated circuit **121**.

According to an embodiment, the display driver integrated circuit **121** may enter the sense mode upon receiving the specified signal. The display driver integrated circuit **121** may apply the first voltage to the other end of the sensing line **160**, for example, the opposite end of the one end connected with the sensing circuit **134** in response to the received specified signal.

According to various embodiments, the first voltage may be applied by various configurations. For example, the first voltage may be applied by any one of the plurality of source amplifiers **130**. For example, the display driver integrated circuit **121** may turn on the first source switch **191***a* and apply a specified value to first image data **221***a*. In this case, the first voltage may be applied by the first source amplifier **131***a*.

According to an embodiment, when entering the sense mode, the display driver integrated circuit **121** may turn on the first group switches **170** such that the sensing line **160** is short circuited from the other end of the sensing line **160** to the sensing circuit **134**. The display driver integrated circuit **121** may turn on the first sharing switch **181***a* such that the sensing line **160** is short-circuited. In an embodiment, if the sensing line **160** is short-circuited, the first voltage applied to the other end of the sensing line **160** may be transmitted to the sensing circuit **134** through the sensing line **160**.

According to an embodiment, the display driver integrated circuit **121** may obtain a second voltage sensed by the sensing circuit **134**. According to an embodiment, the display driver integrated circuit **121** may check information regarding a crack in a region including the sensing line **160** based on a difference between the first voltage and the second voltage. The information regarding the crack may include, for example, whether a crack is present, the degree of the crack, or the location of the crack. In an embodiment, if no crack exists in the region including the sensing line **160**, the difference between the second voltage and the first voltage may be less than or equal to a specified level. In another embodiment, if a crack exists in the region including the sensing line **160**, the difference between the second voltage and the first voltage may exceed the specified level. According to an embodiment, the magnitude of the first voltage or the specified level may be a value previously stored in a memory or the like.

According to an embodiment, the display driver integrated circuit **121** may check whether or not the source amplifier **130** is abnormal, as well as whether or not the region including the sensing line **160** is cracked, by using the sensing circuit **134**. For example, the display driver integrated circuit **121** may check whether or not the source amplifier **130** is abnormal by changing the source amplifier **130** applying the first voltage. In an embodiment, the display driver integrated circuit **121** may control the source amplifiers **130** such that each of the source amplifiers **130** sequentially applies the first voltage to the other end of the sensing line **160** according to a specified time interval example, the display driver integrated circuit **121** may control the first group source switches **190** disposed at the output terminals of the plurality of source amplifiers **130** to be turned on one by one according to the specified time interval. In an embodiment, the display driver integrated circuit **121** may obtain the second voltage corresponding to each first voltage at the specified time interval. The display driver integrated circuit **121** may check whether or not each of the plurality of source amplifiers **130** is abnormal based on the difference between the first voltage and the second voltage at the specified time interval.

In the present disclosure, components having the same reference numerals as those included in the electronic device **200** illustrated in FIG. **2** may be the same as those described in FIG. **2**.

FIG. **3** illustrates a detailed circuit diagram of an electronic device **300** for checking cracks in a connection member **120** and a source amplifier, according to another embodiment.

Referring to FIG. **3**, the electronic device **300** may include a region A-**2** and a region B-**2**. The region A-**2** may be understood as an enlarged view of the region A illustrated in FIG. **1**, and the region B-**2** may be understood as an enlarged view of the region B illustrated in FIG. **1**. In other words, the region A-**2** may represent a portion of the region of the display panel **110**, and the region B-**2** may represent a portion of the connection member **120** on which the display driver integrated circuit **121** is disposed. In the description of FIG. **3**, content that has been already shown in the description of FIG. **2** may be omitted.

Referring to B-**2** region, the display driver integrated circuit **121** may include any one of the plurality of source amplifiers **130**, for example, a multiplexer **310** electrically connected with the first source amplifier **131***a*. In an embodiment, the first source amplifier **131***a* and the multiplexer **310** may be electrically connected through a first decoder **211***a*.

According to an embodiment, the multiplexer **310** may receive the first image data **221***a* and sensing power data **320** as inputs, and may select an output based on the operating state of the electronic device **300**. For example, if the electronic device **300** is in the sense mode, the multiplexer **310** may select the sensing power data **320** as an output and may transmit the sensing power data **320** to the first decoder **211***a*. For another example, if the electronic device **300** is not in the sense mode, the multiplexer **310** may select the first image data **221***a* as an input and may transmit the first image data **221***a* to the first decoder **211***a*. In an embodiment, the operation of the multiplexer **310** may be controlled by a controller (not illustrated) included in the display driver integrated circuit **121**.

According to an embodiment, the sensing power data **320** may be changed based on a user input. For example, if the electronic device **300** is in the sense mode, the display driver integrated circuit **121** may change the value of the sensing power data **320** based on the user input. In this way, the display driver integrated circuit **121** may adjust the output of the first source amplifier **131***a*.

According to an embodiment, the electronic device **300** is in the sense mode, the display driver integrated circuit **121** may turn on the first source switch **191***a* and may apply the output of the first source amplifier **131***a* to the sensing line **160** as the first voltage. The display driver integrated circuit **121** may change the value of the sensing power data **320** and may adjust the magnitude of the first voltage applied to the sensing line **160** by us ng the multiplexer **310**.

In the present disclosure, components having the same reference numerals as those included in the electronic device **300** illustrated in FIG. **3** may be the same as those described in FIG. **3**.

FIG. **4***a* and FIG. **4***b* illustrate detailed circuit diagrams of electronic devices for checking cracks in connection members and source amplifiers, according to yet another embodiment.

Referring to FIG. **4***a*, an electronic device **400***a* may include a region A-**3** and a region B-**3***a*. The region A-**3** may be understood as an enlarged view of the region A illustrated in FIG. and the region B-**3***a* may be understood as enlarged view of the region B illustrated in FIG. **1**. In other words, the region A-**3** may represent a portion of the region of the display panel **110**, and the region B-**3***a* may represent a portion of the connection member **120** on which the display driver integrated circuit **121** disposed. In the description of FIG. **4***a*, content that has been already shown in the description of FIG. **2** may be omitted.

According to an embodiment, the electronic device **400***a* may include at least one of a first module and a second module **42** to apply the first voltage to the sensing line **160**. According to various embodiments, at least one of the first module **41** and the second module **42** illustrated in FIG. **4***a* may be omitted.

According to an embodiment, the first module **41** may include a sense amplifier **410**. The sense amplifier **410** may be a separate amplifier distinguished from the source amplifier **130** and may be electrically connected with the other end of the sensing line **160**. The sense amplifier **410** may apply the first voltage to the sensing line **160** such that cracks in the connection member **120** are checked. In this case, all of the first group source switches **190** disposed at the output terminals of the source amplifiers **130** may be turned off.

According to an embodiment, sensing power data **420** may be input to the sense amplifier **410**. In an embodiment, the sensing power data **420** may be changed based on a user input. For example, if the electronic device **400***a* is in the sense mode, the display driver integrated circuit **121** may change the value of the sensing power data **420** based on the user input. In this way, the display driver integrated circuit **121** may adjust the output of the sense amplifier **410** and the magnitude of the first power supply.

According to an embodiment, the second module may include an external power supply **430** and a power switch **440**. The external power supply **430** may be, for example, a power management module (e.g., a power management module **888** of FIG. **8**) for supplying power to the display driver integrated circuit **121**. For another example, the external power supply **430** may be a power regulator disposed inside the display driver integrated circuit **121** and supplying power to the display panel **110**. In an embodiment, the power switch **440** may be disposed between the external power supply **430** and the sensing line **160**.

According D an embodiment, the external power supply **430** may include terminals for connection to at least a portion of the display driver integrated circuit **121**, for example, general purpose input output (GPIO) terminals. The external power supply **430** may provide the first voltage to at least a portion of the display driver integrated circuit **121**, for example, to the other end of the sensing line, through the terminals. According to various embodiments, the external power supply **430** may be disposed on the FPCB **11** or the M-PCB **12** illustrated in FIG. **1**.

According to an embodiment, if the electronic device **400***a* in the sense mode, the display driver integrated circuit **121** may turn on the power switch **440**. The external power supply **430** may apply the first voltage to the sensing line **160** through the power switch **440**.

As described above, the electronic device **400***a* may apply the first voltage to the sensing line **160** through the first module or the second module **42**, and the display driver integrated circuit **121** may check whether not the region including the sensing line **160** is cracked through the first voltage and the second voltage obtained through the sensing circuit **134**.

Referring to FIG. **4***b*, an electronic device may include a region A-**3** and a region B-**3***b*. The region B-**3***b* may be understood as an enlarged view of the region B illustrated in FIG. **1**. In other words, the region B-**3***b* may represent a portion of the connection member **120** in which the display driver integrated circuit **121** is disposed. In the description of FIG. **4***b*, content that has been already shown in the description of FIG. **2** or the description of FIG. **4***a* may be omitted.

According to an embodiment, an electronic device **400***b* may omit the first module **41** and the second module **42** and include a sensing module **460**, unlike the electronic device **400***a* illustrated in FIG. **4***a*. The sensing module **460** may be understood as an integrated circuit (IC) including the external power supply **430** and the sensing circuit **134**. According to an embodiment, the sensing module **460** may be disposed outside the display driver integrated circuit **121**, for example, on the FPCB **11** or the M-PCB **12** illustrated in FIG. **1**.

According to an embodiment, the sensing module **460** may transmit the specified power to the display driver integrated circuit **121** by using the external power supply **430**. For example, the sensing module **460** may apply the first voltage to the sensing line **160** by using the external power supply **430**. The external power supply **430** may be, for example, a power management module (e.g., the power management module **888** of FIG. **8**) for supplying power to the display driver integrated circuit **121**.

According to an embodiment, the sensing module **460** may check whether or not the region including the sensing line **160** is cracked by using the sensing circuit **134**. For example, the sensing module **460** may obtain the magnitude of the second voltage measured at one end of the sensing line **160** by using the sensing circuit **134**. The sensing module **460** may check whether or not the region including the sensing line **160** is cracked through the first voltage and the second voltage.

In the present disclosure, components having the same reference numerals as those included in the electronic device **400***a* illustrated in FIG. **4***a* or the electronic device **400***b* illustrated in FIG. **4***b* are the same as those described in FIG. **4***a* or FIG. **4***b*.

FIG. **5** illustrates a detailed circuit diagram of an electronic device including a plurality of sensing lines, according to an embodiment.

Referring to FIG. **5**, an electronic device may include a region A-**4** and a region B-**4**. The region A-**4** may be understood as an enlarged view of the region A illustrated in FIG. **1**, and the region B-**4** may be understood as an enlarged view of the region B illustrated in FIG. **1**. In other words, the region A-**4** may represent a portion of the region of the display panel **110**, and the region B-**4** may represent a portion of the connection member **120** on which the display driver integrated circuit **121** is disposed. In the description of FIG. **5**, content that has been already shown in the description of FIG. **2** may be omitted.

Referring to B-**4**, the display driver integrated circuit **121** may include the sense amplifier **410**. The sense amplifier **410** may be a separate amplifier distinguished from the source amplifier and may be electrically connected with the other ends of sensing lines **160***a*, **160***b*, **160***c*, and **160***d*. The sense amplifier **410** may apply a first voltage to the sensing lines **160***a*, **160***b*, **160***c*, and **160***d* so as to check cracks in the region including the sensing lines **160***a*, **160***b*, **160***c*, and **160***d*. In this case, all of the first group source switch **190** disposed at the output terminals of the source amplifiers **130** may be turned off.

According to an embodiment, sensing power data **420** may be input to the sense amplifier **410**. In an embodiment, the sensing power data **420** may be changed based on a user input. For example, if the electronic device **500** is in the sense mode, the display driver integrated circuit **121** may change the value of the sensing power data **420** based on the user input. In this way, the display driver integrated circuit **121** may adjust the output of the sense amplifier **410** and the magnitude of the first power supply.

According to an embodiment, first group sharing switches **510** may be disposed on the sensing lines **160***a*, **160***b*, **160***c*, and **160***d*. In an embodiment, the first group sharing switches **510** may be disposed between at least some of the first group lines **140** such that at least sub-pixels having the same characteristics are selectively connected with each other. For example, a first sharing switch **511***a* may be disposed between lines connected with red sub-pixels **111_1***a*, **112_1***a*, and **113_1***a* of the n-th gate line, for example, between the first line **141***a* and the fifth line **142***a*. For another example, a second sharing switch **511***b* may be disposed between lines connected with green sub-pixels **111_1***b*, **112_1***b*, and **113_1***b* of the n-th gate line, for example, between the second line **141***b* and the sixth line **142***b*. For yet another example, a third sharing switch **511***c* may be disposed between lines connected with blue sub-pixels **111_1***c*, **112_1***c*, and **113_1***c* of the n-th gate line, for example, between the third line **141***c* and the seventh line **142***c*.

According to an embodiment, since the first group sharing switches **510** connect some of the first group lines **140** according to the characteristics of the sub-pixels, the electronic device **500** may include at least one of the sensing lines **160***a*, **160***b*, **160***c*, and **160***d* according to the characteristics of the sub-pixels. For example, the electronic device **500** may include the first sensing line **160***a* connected with the red sub-pixels **111_1***a*, **112_1***a*, and **113_1***a* of the n-th gate line, the second sensing line **160***b* and the fourth sensing line **160***d* connected with the green sub-pixels **111_1***b*, **112_1***b*, **113_1***b*, **111_1***d*, **112_1***d*, and **113_1***d* of the n-th gate line, and the third sensing line **160***c* connected with the blue sub-pixels **111_1***c*, **112_1***c*, and **113_1***c* of the n-th gate line.

According to an embodiment, first group switches **170***a*, **170***b*, **170***c*, and **170***d* may be disposed on at least one sensing line, respectively. For example, the first switch **170***a* may be disposed between the sense amplifier **410** and the first sharing switch **511***a* on the first sensing line **160***a*. For another example, the second switch **170***b* may be disposed between the sense amplifier **410** and the second sharing switch **511***b* on the second sensing line **160***b*. Similarly to the above, the third switch **170***c* or the fourth switch **170***d* may be disposed on the third sensing line **160***c* or the fourth sensing line **160***d*, respectively.

According to an embodiment, if the electronic device **500** is in the sense mode, the display driver integrated circuit **121** may turn on the first group switches **170***a*, **170***b*, **170***c*, and **170***d* and the first group sharing switches **510** such that the sensing lines **160***a*, **160***c*, and **160***d* are short-circuited from the other ends of the sensing line **160***a*, **160***b*, **160***c*, and **160***d* to the sensing circuit **134**. In an embodiment, the display driver integrated circuit **121** may control the first group switches **170***a*, **170***b*, **170***c*, and **170***d* and the first group sharing switches **510** such that each of the sensing lines **160***a*, **160***b*, **160***c*, and **160***d* is sequentially short-circuited according to a specified time interval.

For example, the display diver integrated circuit **121** may control the first group switches **170***a*, **170***b*, **170***c*, and **170***d* and the first group sharing switches **510** such that the first sensing line **160***a* is short-circuited for a first time. If the first voltage is applied from the sense amplifier **410** to the first sensing line **160***a*, the display driver integrated circuit **121** may compare the second voltage obtained by the sensing circuit **134** for the first time with the first voltage to check whether or not the region including the sensing line **160***a* is cracked.

For another example, the display driver integrated circuit **121** may control the first group switches **170***a*, **170***b*, **170***c*, and **170***d* and the first group sharing switches **510** such that the second sensing line **160***b* is short-circuited for a second time that is distinguished from the first time. If the first voltage is applied from the sense amplifier **410** to the second sensing line **160***b*, the display driver integrated circuit **121** may compare the second voltage obtained by the sensing circuit **134** for the second time with the first voltage to check whether or not the region including the sensing line **160***b* is cracked.

For another example, the display driver integrated circuit **121** may control the first group switches **170***a*, **170***b*, **170***c*, and **170***d* and the first group sharing switches **510** such that the first voltage is applied to the third sensing line **160***c* or the fourth sensing line **160***d* for a third time or a fourth time that is distinguished from the first time and the second time.

The display driver integrated circuit **121** may check whether or not at least some region of the electronic device **500** is cracked through the third sensing line **160***c* or the fourth sensing line **160***d*.

In the present disclosure, components having the same reference numerals as those included in the electronic device **500** illustrated in FIG. **5** may be the same as those described in FIG. **5**.

FIG. **6***a* and FIG. **6***b* illustrate detailed circuit diagrams of electronic devices for checking cracks in a gate amplifier, according to an embodiment.

Referring to FIG. **6***a*, an electronic device **600***a* may Include a region A-**5** and a region B-**5***a*. The region A-**5** may be understood as an enlarged view of the region A illustrated in FIG. **1**, and the region B-**5***a* may be understood as an enlarged view of the region B illustrated in FIG. **1**. In other words, the region A-**5** may represent a portion of the region of the display panel **110**, and the region B-**5***a* may represent a portion of the connection member **120** on which the display driver integrated circuit **121** is disposed. In the description of FIG. **6***a*, content that has been already shown in the description of FIG. **2** may be omitted.

Referring to A-**5**, a gate driver **610** and gate lines for providing a gate voltage to each pixel may be disposed on the display panel **110**. The gate driver **610** may sequentially apply gate voltages received from gate amplifiers **135**, **136**, and **137** to respective gate lines. If the gate voltage applied to the gate line, a transistor connected with each of the pixels included in the gate line is active, and a source voltage may be applied to the pixels. The pixels may emit light based on the source voltage.

Referring to B-**5**, the display driver integrated circuit **121** may include the gate amplifiers **135**, **136**, and **137** for providing the gate voltage. According to an embodiment, the gate amplifiers **135**, **136**, and **137** may be electrically connected with pixels of the display panel **110** through the second group lines **150**. In an embodiment, the gate driver **610** may be disposed between the second group lines **150**. The gate driver **610** may sequentially transmit the gate voltages received through the second group lines **150** to respective gate lines.

According to an embodiment, first group gate switches **631***a*, **631***b*, and **631***c* may be disposed at the output terminals of the gate amplifiers **135**, **136**, and **137**. The first group gate switches **631***a*, **631***b*, and **631***c* may activate or deactivate the outputs of the respective gate amplifiers **135**, **136**, and **137**. For example, if the electronic device **600***a* is in the sense mode for checking cracks in the region including the sensing line **160**, the display driver integrated circuit **121** may turn off all of the first group gate switches **631***a*, **631***b*, and **631***c*. In this case, the outputs of the gate amplifiers **135**, **136**, and **137** may not be applied to the sensing circuit **134**, but the first voltage may be applied to the sensing circuit **134** from the external power supply **430**. For another example, if the electronic device **600***a* is in the sense mode for sensing an abnormality in the gate amplifiers **135**, **136**, and **137**, the display driver integrated circuit **121** may sequentially turn on the first group gate switches **631***a*, **631***b*, and **631***c* according to a specified time interval. In this case, the outputs of the gate amplifiers **135**, **136**, and **137** may be sequentially applied one by one to the sensing circuit **134**.

According to an embodiment, the second group lines **150** may cross the sensing line **160** like the first group lines **140**. In an embodiment, second group sharing switches **611***a*, **611***b*, and **611***c* may be disposed between the second group lines **150**. In another embodiment, the second group sharing switches **611***a*, **611***b*, and **611***c* may be disposed between at least one of the second group lines **150** and at least one of the first group lines **140**.

According to an embodiment, the electronic device **600***a* may include the external power supply **430** and the power switch **440**. The external power supply **430** may be, for example, a power management module (e.g., the power management module **888** of FIG. **8**) for supplying power to the display driver integrated circuit **121**. For another example, the external power supply **430** may be a power regulator disposed inside the display driver integrated circuit **121** and supplying power to the display panel **110**. In an embodiment, the power switch **440** may be disposed between the external power supply **430** and the sensing line **160**.

According to an embodiment, the external power supply **430** may include terminal for connection to at least a portion of the display driver integrated circuit **121**, for example, general purpose input output (GPIO) terminals. The external power supply **430** may provide the first voltage to at least a portion of the display driver integrated circuit **121**, for example, to the other end of the sensing line, through the terminals. In various embodiments, the external power supply **430** may be disposed on the FPCB **11** or the M-PCB **12** illustrated in FIG. **1**.

According to an embodiment, if the electronic device **600***a* is in the sense mode for checking cracks in the region including the sensing line **160**, the display driver integrated circuit **121** may turn on the power switch **440**. The external power supply **430** may apply the first voltage to the sensing line **160** through the power switch **440**. In an embodiment, the display driver integrated circuit **121** may turn on the first group switches **170**, the first group sharing switches **180**, and the second group sharing switches **611***a*, **611***b*, and **611***c* such that the sensing line **160** is short-circuited. In this case, all of the first group gate switches **631***a*, **631***b*, and **631***c* may be turned off. In this way, the first voltage applied from the external power supply **430** may be transmitted to the sensing circuit **134** through the sensing line **160**. The display driver integrated circuit **121** may check whether or not the region including the sensing line **160** is cracked through the first voltage and the second voltage obtained through the sensing circuit **134**.

According to another embodiment, if the electronic device **600***a* is in the sense mode for sensing an abnormality in the gate amplifiers **135**, **136**, and **137** or the source amplifiers **130**, the display driver integrated circuit **121** may turn off the power switch **440** and may turn on the first group switches **170**, the first group sharing switches **180**, and the second group sharing switches **611***a*, **611***b*, and **611***c* such that the sensing line **160** is short-circuited. In an embodiment, the display driver integrated circuit **121** may sequentially turn on or off the first group gate switches **631***a*, **631***b*, and **631***c* and the first group source switches **190** one by one according to a specified time interval. In this case, the plurality of gate amplifiers **135**, **136**, and **137** and the plurality of source amplifiers **130** may sequentially apply the first voltage to the sensing line **160** one by one according to the specified time interval. The display driver integrated circuit **121** may check whether or not the gate amplifiers **135**, **136**, and **137** and the source amplifiers **130** are abnormal through the first voltage and the second voltage obtained through the sensing circuit **134**.

Referring to FIG. **6***b*, an electronic device may include a region A-**5** and a region B-**5***b*. The region B-**5***b* may be understood as an enlarged view of the region B illustrated in FIG. In other words, the region B-**5***b* may represent a portion of the connection member **120** in which the display driver integrated circuit is disposed. In the description of FIG. **6***b*, content that has been already shown in the description of FIG. **2** or the description of FIG. **6***a* may be omitted.

According to an embodiment, an electronic device **600***b* may include the sensing module **460**, unlike the electronic device **600***a* illustrated in FIG. **6***a*. The sensing module **460** may be understood as an integrated circuit (IC) including the external power supply **430** and the sensing circuit **134**. According to an embodiment, the sensing module **460** may be disposed outside the display driver integrated circuit **121**, for example, on the FPCB **11** or the M-PCB **12** illustrated in FIG. **1**.

According to an embodiment, the sensing module **460** may transmit the specified power to the display driver integrated circuit **121** by using the external power supply **430**. For example, the sensing module **460** may apply the first voltage to the sensing line **160** by using the external power supply **430**. The external power supply **430** may be, for example, a power management module (e.g., the power management module **888** of FIG. **8**) for supplying power to the display driver integrated circuit **121**.

According to an embodiment, the sensing module **460** may check whether or not the gate amplifiers **135**, **136**, and **137** and the source amplifiers **130** are abnormal by using the sensing circuit **134**. For example, the sensing module **460** may obtain the magnitude of the second voltage measured at one end of the sensing line **160** by using the sensing circuit **134**. The sensing module **460** may check whether or not the gate amplifiers **135**, **136**, and **137** and the source amplifiers **130** are abnormal through the first voltage and the second voltage.

In the present disclosure, components having the same reference numerals as those included in the electronic device **600***a* illustrated in FIG. **6***a* or the electronic device **600***b* illustrated in FIG. **6***b* are the same as those described in FIG. **6***a* or FIG. **6***b*.

FIG. **7***a* and FIG. **7***b* illustrated detailed circuit diagrams of electronic devices for checking cracks in a display panel, according to an embodiment.

Referring to FIG. **7***a*, an electronic device **700***a* may include a region A-**6** and a region B-**6***a*. The region A-**6** may be understood as an enlarged view of the region A illustrated in FIG. **1**, and the region B-**6***a* may be understood as an enlarged view of the region B illustrated in FIG. **1**. In other words, the region A-**6** may represent a portion of the region of the display panel **110**, and the region B-**6***a* may represent a portion of the connection member **120** on which the display driver integrated circuit **121** is disposed. In the description of FIG. **7***a*, content that has been already shown in the descriptions of FIG. **2** and FIG. **6***a* may be omitted.

Referring to A-**6**, first group transistors **710** may be additionally disposed at one end of the display panel **110**. According to an embodiment, the first group transistors **710** may be electrically connected one ends of the first group lines **140**. In an embodiment, the first group transistors **710** may not be connected with the light emitting device unlike other transistors disposed on the display panel **110**. For example, the first group transistors **710** may be electrically connected with the external power supply **430**, instead of the light emitting device, through a power supply line **730**.

According to an embodiment, a separate gate line **720** may be additionally connected with the first group transistors **110**. For example, the separate gate line **720** is electrically connected with the gate terminals of the first group transistors **710**, and the first group transistors **710** may receive a gate voltage through the separate gate line **720**.

Referring to B-**6**, the display driver integrated circuit **121** may include second group switches **740**. According to an embodiment, the second group switches **740** may be disposed on the first group lines **140** and may short-circuit or open the first group lines **140**. For example, if the electronic device **700***a* is not in the sense mode, the second group switches **740** may be turned on, and the first group lines **140** may be short-circuited. The pixels may receive the source voltage through the first group lines **140**. For another example, if the electronic device **700***a* is in the sense mode for checking an abnormality in the display panel **110**, at least some of the second group switches **740** may be turned on and the remaining portion of the second group switches **740** may be turned off. In this case, at least some of the first group Lines **140** may be short-circuited and the remaining portion of the first group lines **140** may be opened. In an embodiment, the first voltage applied from the external device through the first group transistors **710** may be applied to the sensing line **160** through the short-circuited lines.

According to an embodiment, the electronic device **700***a* may include the external power supply **430**, a first power switch **440**, and a second power switch **450**. The external power supply **430** may be, for example, a power management module (e.g., the power management module **888** of FIG. **8**) for supplying power to the display driver integrated circuit **121**. For another example, the external power supply **430** may be a power regulator disposed inside the display drier integrated circuit **121** and supplying power to the display panel **110**. In an embodiment, the first power switch **440** may be disposed between the external power supply **430** and the sensing, line **160**, and the second power switch **450** may be disposed between the external power supply **430** and the power supply line **730**.

According to an, embodiment, the external power supply **430** may include terminals for connection to at least a portion of the display driver integrated circuit **121**, for example, general purpose input output (GPIO) terminals. The external power supply **430** may provide the first voltage to at least a portion of the display driver integrated circuit **121**, for example, to the other end, of the sensing line, through the terminals. According to various embodiments, the external power supply **430** may be disposed on the FPCB **11** or the M-PCB **12** illustrated in FIG. **1**.

According to an embodiment, the first power switch **440** or the second power switch **450** may be selectively turned on. For example, if the electronic device **700***a* is in the sense mode for checking cracks in the region including the sensing line **160**, the first power switch **440** may be turned on and the second power switch **450** may be turned off. For another example, if the electronic device **700***a* is in the sense mode for checking an abnormality in the display panel **110**, the first power switch **440** may be turned off and the second power switch **450** may be turned on.

According to an embodiment, if the electronic device **700***a* is in the sense mode for checking an abnormality in the display panel **110**, the display driver integrated circuit **121** may apply the gate voltage to the first group transistors **710** through the separate gate line **720** by using the gate amplifiers **135**, **136**, and **137**. If the gate voltage is applied to the first group transistors **710**, the first group transistors **710** may be turned on. The turned-on first group transistors **710** may transmit, to the first group lines **140**, the first voltage applied from the external power supply **430** through the power supply line **730**.

According to an embodiment, if the electronic device **700***a* is in the sense mode for checking an abnormality in the display panel **110**, the display driver integrated circuit **121** may turn on at least some of the second group switches **740**. In this case, some of the first group lines **140** may be short-circuited through the turned-on second group switches **740**, and the first voltage may be applied to the sensing line **160**. In this case, the display driver integrated circuit **121** may check whether or not pixels or sub-pixels included in the short-circuited first group lines **140** are abnormal by using the first voltage and the second voltage obtained through the sensing circuit **134**.

According to an embodiment, if the electronic device **700***a* is in the sense mode for checking cracks in the display panel **110**, the display driver integrated circuit **121** may sequentially turn on any one of the second group switches **740** according to a specified time interval. In this case, any one of the first group lines **140** may be sequentially turned on according to the specified time interval. The display driver integrated circuit **121** may sequentially check whether or not pixels or sub-pixels are abnormal by using the first voltage and the second voltage corresponding to the first voltage according to the specified time interval.

Referring to FIG. **7***b*, an electronic device may include a region A-**6** and a region B-**6***b*. The region B-**6***b* may be understood as an enlarged view of the region B illustrated in FIG. **1**. In other words, the region B-**6***b* may represent a portion of the connection member **120** in which the display driver integrated circuit **121** is disposed. In the description of FIG. **7***b*, content that has been already shown in the description of FIG. **2** or the description of FIG. **7***a* may be omitted.

According to an embodiment, the electronic device **700***b* may include the sensing module **460**, unlike the electronic device **700***a* illustrated in FIG. **7***a*. The sensing module **460** may be understood as an integrated circuit (IC) including the external power supply **430** and the sensing circuit **134**. According to an embodiment, the sensing module **460** may be disposed outside the display driver integrated circuit **121**, for example, on the FPCB **11** or the M-PCB **12** illustrated in FIG. **1**.

According to an embodiment, the sensing module **460** may transmit the specified power to the display driver integrated circuit **121** by using the external power supply **430**. For example, the sensing module **460** may apply the first voltage to the sensing line **160** by using the external power supply **430**. The external power supply **430** may be, for example, a power management module (e.g., the power management module **888** of FIG. **8**) for supplying power to the display driver integrated circuit **121**.

According to an embodiment, the sensing module **460** may check whether or not pixels or sub-pixels are abnormal using the sensing circuit **134**. For example, the sensing module **460** may obtain the magnitude of the second voltage measured, at one cup of the sensing line **160** by using the sensing circuit **134**. The sensing module **460** may check whether or not pixels or sub-pixels are abnormal through the first voltage and the second voltage.

FIG. **8** is a block diagram illustrating an electronic device **801** in, a network environment **800** according to various embodiments. Referring to FIG. **8**, the electronic device **801** in the network environment **800** may communicate with an electronic device **802** via a first network **898** (e.g., a short-range wireless communication network), or an electronic device **804** or a server **808** via a second network **899** (e.g., a long-range wireless communication network). According to an embodiment, the electronic device **801** may communicate with the electronic device **804** via the server **808**. According to an embodiment, the electronic device **801** may include a processor **820**, memory **830**, an input device **850**, a sound, output device **855**, a display device **860**, an audio module **870**, a sensor module **876**, an interface **877**, a haptic module **879**, a camera module **880**, a power management module **888**, a battery **889**, a communication module **890**, a subscriber identification module (SIM) **896**, or an antenna module **997**. In some embodiments, at least one (e.g., the display device **860** or the camera module **880**) of the components may be omitted from the electronic device **801**, or one or more other components may be added in the electronic device **301**. In some embodiments, some of the components may be implemented as single integrated circuitry. For example, the sensor module **876** (e.g., a fingerprint sensor, an iris sensor, or an illuminance sensor) may be implemented as embedded in the display device **860** (e.g., a display).

The processor **820** may execute, for example, software (e.g., a program **840**) to control one other component (e.g., a hardware or software component) of the electronic device **801** coupled with the processor **820**, and may perform various data processing of computation. According to one embodiment, as at least part of the data processing or computation, the processor **820** may load a command or data received from another component (e.g., the sensor module **876** or the communication module **890**) in volatile memory **832**, process the command or the data stored in the volatile memory **932**, and store resulting data in non-volatile memory **834**. According to an embodiment, the processor **820** may include a main processor **821** (e.g., a central processing unit (CPU) or an application processor (AP)), and an auxiliary processor **323** (e.g., a graphics processing unit (GPU), an image signal processor (ISP), a sensor hub processor, or a communication processor (CP)) that is operable independently from, or in conjunction with, the main processor **821**. Additionally or alternatively, the auxiliary processor **823** may be adapted to consume less power than the main processor **821**, or to be specific to a specified function. The auxiliary processor **823** may be implemented as separate from, or as part of the main processor **821**.

The auxiliary processor **823** may control at least some of functions or states related to at least one component the display device **860**, the sensor module **876**, or the communication module **890**) among the components of the electronic device **801**, instead of the main processor **821** while the main processor **821** is in an inactive (e.g., sleep) state, or together with the main processor **821** while the main processor **821** is in an active state (e.g., executing an application). According to an embodiment, the auxiliary processor **823** (e.g., an image signal processor or a communication processor) may be implemented as part of another component the (e.g., the camera module **880** or the communication module **890**) functionally related to the auxillary processor **823**.

The memory **830** may store various data used by at least one component (e.g., the processor **820** or the sensor module **876**) of the electronic device **801**. The various data may include, for example, software (e.g., the program **840**) and input data or output data for a command related thererto. The memory **830** may include the volatile memory **832** or the non-volatile memory **834**.

The program **840** may be stored in the memory **830** as software, and may include, for example, an operating system (OS) **842**, middleware **844**, or an application **846**.

The input device **850** may receive a command or data to be used by other component (e.g., the processor **820**) of the electronic device **801**, from the outside (e.g., a user) of the electronic device **801**. The input device **850** may include, for example, a microphone, a mouse, or a keyboard.

The sound output device **855** may output sound signals to the outside of the electronic device **801**. The sound output device **855** may include, for example, a speaker or a receiver. The speaker may be used for general purposes, such as playing multimedia or playing record, and the receiver may be used for an incoming calls. According to an embodiment, the receiver may implemented as separate from, or as part of the speaker.

The display device **860** may visually provide information to the outside (e.g., a user) of the electronic device **801**. The display device **860** may include, for example, a display, a hologram device, or a projector and control circuitry to control a corresponding one of the display, hologram device, and projector. According to an embodiment, the display device **860** may include touch circuitry adapted to detect a touch, or sensor circuitry (e.g., a pressure sensor) adapted to measure the intensity of force incurred by the touch.

The audio module **870** may convert a sound into an electrical signal and vice versa. According to an embodiment, the audio module **870** may obtain the sound via the input device **850**, or output the sound via the sound output device **855** or a headphone of an external electronic device (e.g., an electronic device **802**) directly (e.g., wiredly) or wirelessly coupled with the electronic device **801**.

The sensor module **876** may detect an operational state (e.g., power or temperature) of the electronic device **801** or an environmental state (e.g., a state of user) external to the electronic device **801**, and then generate an electrical signal or data value corresponding to the detected state. According to an embodiment, the sensor module **876** may include, for example, a gesture sensor, a gyro sensor, an atmospheric pressure sensor, a magnetic sensor, an acceleration sensor, a grip sensor, a proximity sensor, color sensor, an infrared (IR) sensor, a biometric sensor, a temperature sensor, a humidity sensor, or an illuminance sensor.

The interface **877** may support one or more specified protocols to be used for the electronic device **801** to be coupled with the external electronic device (e.g., the electronic device **802**) directly (e.g., wiredly) or wirelessly. According to an embodiment, the interface **877** may include, for example, a high definition multimedia interface (HDMI), a universal serial bus (USB) interface, a secure digital (SD) card interface, or an audio interface.

A connecting terminal **878** may include a connector via which the electronic device **801** may be physically connected with the external electronic device (e.g., the electronic device **802**). According to an embodiment, the connecting terminal **878** may include, for example, a HDMI connector, a USE connector, a SD card connector, or an audio connector (e.g., a headphone connector).

The haptic module **879** may convert an electrical signal into a mechanical stimulus (e.g., a vibration or a movement) or electrical stimulus which may be recognized by a user via his tactile sensation or kinesthetic sensation. According to an embodiment, the haptic module **879** may include, for example, a motor, a piezoelectric element, or an electric stimulator.

The camera module **880** may capture a still image or moving images. According to an embodiment, the camera module **880** may include or more lenses, image sensors, image signal processors, or flashes.

The power management module **888** may manage power supplied to the electronic device **801**. According to one embodiment, the power management module **888** may be implemented as at least part of, for example, a power management integrated circuit (PMIC).

The battery **889** may supply power to at least one component of the electronic device **801**. According to an embodiment, the battery **889** may include, for example, a primary cell which is not rechargeable, a secondary cell which is rechargeable, or a fuel cell.

The communication module **890** may support establishing a direct (e.g., wired) communication channel or a wireless communication channel between the electronic device **801** and the external electronic device (e.g., the electronic device **802**, the electronic device **804**, or the server **808**) and performing communication via the established communication channel. The communication module **890** may include one or more communication processors that are operable independently from the processor **820** (e.g., the application processor (AP)) and supports a direct (e.g., wired) communication or a wireless communication. According to an embodiment, the communication module **890** may include a wireless communication module **892** (e.g., a cellular communication module, a short-range wireless communication module, or a global navigation satellite system (GNSS) communication module) or a wired communication module **894** (e.g., a local area network (LAN) communication module or a power line communication (PLC) module). A corresponding one these communication modules may communicate with the external electronic device via the first network **898** (e.g., a short-range communication network, such as Bluetooth™, wireless-fidelity (Wi-Fi) direct, or infrared data association (IrDA)) or the second network **899** (e.g., a long-range communication network, such as a cellular network, the Internet, or a computer network (e.g., LAN or wide area network (WAN)). These various types of communication modules may be implemented as a single component (e.g., a single chip), or may be implemented as multi components (e.g., multi chips) separate from each other. The wireless communication module **892** may identify and authenticate the electronic device **801** in a communication network, such as the first network **898** or the second network **899**, using subscriber information (e.g., international mobile subscriber identity (IMSI)) stored in the subscriber identification module **896**.

The antenna module **897** may transmit or receive a signal or power to or from the outside (e.g., the external electronic device) of the electronic device **801**. According to an embodiment, the antenna module **897** may include one or more antennas, and, therefrom, at least one antenna appropriate for a communication scheme used in the communication network, such as the first network **898** or the second network **899**, may be selected, for example, by the communication module **890** (e.g., the wireless communication module **892**). The signal or the power may then be transmitted or received between the communication module **890** and the external electronic device via the selected at least one antenna.

At least some of the above-described components may be coupled mutually and communicate signals (e.g., commands or data) therebetween via an inter-peripheral communication scheme (e.g., a bus, general purpose input and output (GPIO), serial peripheral interface (SPI), or mobile industry processor interface (MIPI)).

According to an embodiment, commands or data may be transmitted or received between the electronic device **801** and the external electronic device **804** via the server **808** coupled with the second network **899**. Each of the electronic devices **802** and **804** may be a device of a same type as, or a different type, from the electronic device **801**. According to an embodiment, all or some of operations to be executed at the electronic device **801** may be executed at one or more of the external electronic devices **802**, **804**, or **808**. For example, if the electronic device **801** should perform a function or a service automatically, or in response to a request from user or another device, the electronic device **801**, instead of, or in addition to, executing the function or the service, may request the one or more external electronic devices to perform at least part of the function or the service. The one or more external electronic devices receiving the request may perform the at least part of the function or the service requested, or an additional function or an additional service related to the request, and transfer an outcome of the performing to the electronic device **801**. The electronic device **801** may provide the outcome, with or without further processing of the outcome, as at least part of a reply to the request. To that end, a cloud computing, distributed computing, or client-server computing technology may be used, for example.

FIG. **9** is a block diagram **900** illustrating the display device **860** according to various embodiments. Referring to FIG. **9**, the display device **860** may include a display **910** and a display driver integrated circuit (DDI) **930** to control the display **910**. The DDI **930** may include an interface module **931**, memory **933** (e.g., buffer memory), an image processing module **935**, or a mapping module **937**. The DPI **930** may receive image information that contains image data or an image control signal corresponding to a command to control the image data from another component of the electronic device **801** via the interface module **931**. For example, according to an embodiment, the image information may be received from the processor **820** (e.g., the main processor **821** (e.g., an application processor)) or the auxiliary processor **823** (e.g., a graphics processing unit) operated independently from the function of the main processor **821**. The DDI **930** may communicate, for example, with touch circuitry **850** or the sensor module **876** via the interface module **931**. The DDI **930** may also store at least part of the received image information in the memory **933**, for example, on a frame by frame basis.

The image processing, module **935** may perform pre-processing or post-processing (e.g., adjustment of resolution, brightness, or size) with respect to at least part of the image data. According to an embodiment, the pre-processing or post-processing may be performed, for example, based at least in part on one or more characteristics of the image data or one or more characteristics of the display **910**.

The mapping module **937** may generate a voltage value or a current value corresponding to the image data pre-processed or post-processed by the image processing module **935**. According to an embodiment, the generating of the voltage value or current value may be performed, for example, based at least in part on one or more attributes of the pixels (e.g., an array, such as an RGB stripe or a pentile structure, of the pixels, or the size of each subpixel). At least some pixels of the display **910** may be driven, for example, based at least in part on the voltage value or the current, value such that visual information (e.g., a text, an image, or an icon) corresponding to the image data may be displayed via the display **910**.

According to an embodiment, the display device **860** may further include the touch circuitry **950**. The touch circuitry **950** may include a touch sensor **951** and a touch sensor IC **953** to control the sensor **951**. The touch sensor IC **953** may control the touch sensor **951** to sense a touch input or a hovering input with respect to a certain position on the display **910**. To achieve this, for example, the touch sensor **951** may detect (e.g., measure) a change in a signal (e.g., a voltage, a quantity of light, a resistance, or a quantity of one or more electric charges) corresponding to the certain position on the display **910**. The touch circuitry **950** may provide input information (e.g., a position, an area, a pressure, or a time) indicative of the touch input or the hovering input detected via the touch sensor **951** to the processor **820**. According to an embodiment, at least part (e.g., the touch sensor IC **953**) of the touch circuitry **950** may be formed as part of the display **910** or the DDI **930**, or as part of another component (e.g., the auxiliary processor **823**) disposed outside the display device **860**.

According to an embodiment, the display device **860** may further include at least one sensor (e.g., a fingerprint sensor, an iris sensor, a pressure sensor, or an illuminance sensor) of the sensor module **876** or a control circuit for the at least one sensor. In such a case, the at least one sensor or the control circuit for the at least one sensor may be embedded in one portion of a component (e.g., the display **910**, the DDI **930**, or the touch circuitry **850**)) of the display device **860**. For example, when the sensor module **876** embedded in the display device **860** includes a biometric sensor (e.g., a fingerprint sensor), the biometric sensor may obtain biometric, information (e.g., a fingerprint image) corresponding to a touch input received via a portion of the display **910**. As another example, when the sensor module **876** embedded in the display device **860** includes a pressure sensor, the pressure sensor may obtain pressure information corresponding to a touch input received via a partial or whole area of the display **910**. According to an embodiment, the touch sensor **951** or the sensor module **876** may be disposed between pixels in a pixel layer of the display **910**, or over or under the pixel layer.

An electronic device according to an embodiment of the present disclosure may include a display panel on which a plurality of pixels are arranged, first group lines providing a source voltage to each of the plurality of pixels, a display driver integrated circuit that includes a plurality of source amplifiers electrically connected with the first group lines and providing the source voltage to each of the plurality of pixels, at least one sensing line crossing the first group lines, and first group switches disposed on the at least one sensing line, and a sensing circuit electrically connected with one end of the at least one sensing line to check a crack in at least a partial region of the electronic device, in which the display driver integrated circuit receives a specified signal for the electronic device to enter a sense mode, applies a first voltage to the other end of the at least one sensing line that is distinguished from the one end of the at least one sensing line, in response to the received specified signal, turns on the first group switches such that the at least one sensing line is short-circuited from the other end of the at least one sensing line to the sensing circuit, obtains a second voltage sensed by the sensing circuit electrically connected with the one end of the at least one sensing line, and checks information regarding the crack in the at least partial region of the electronic device based on a difference between the first voltage and the second voltage.

According to an embodiment, the display driver integrated circuit may apply the first voltage to the other end of the at least one sensing line by using any one of the plurality of source amplifiers, in response to the received specified signal.

According to an embodiment, the plurality of source amplifiers may further include first group source switches respectively disposed at output terminals of the plurality of source amplifiers, and the display driver integrated circuit may turn on the source switch disposed at the output terminal of any one of the source amplifiers among the first group source switches, in response to the received specified signal.

According to an embodiment, the display driver integrated circuit may further include a multiplexer electrically connected with an input terminal of any one of the source amplifiers, and may adjust a magnitude of the output voltage of the one of the source amplifiers by using the multiplexer.

According to an embodiment, the display driver integrated circuit may sequentially app the first voltage to the other end of the at least one sensing line by sequentially using the plurality of source amplifiers one by one according to a specified time interval, and may sequentially check whether or not each of the plurality of source amplifiers is abnormal based on the difference between the first voltage and the second voltage, according to the specified time interval. According to an embodiment, the plurality of source amplifiers may further include first group source switches respectively, disposed at output terminals of the plurality of source amplifiers, and the display driver integrated circuit may sequentially apply the first voltage to the other end of the at least one sensing line according to the specified time interval by sequentially turning on the first group source switches one by one according to the specified time interval.

According to an embodiment, the display driver integrated circuit may further include sense amplifier electrically connected with the other end of the at least one sensing line, and may apply the first voltage to the other end of the at least one sensing line by using the sense amplifier, in response to the received specified signal.

According to an embodiment, the display driver integrated circuit may further include a multiplexer electrically connected with an input terminal of the sense amplifier, and may adjust a magnitude of the output voltage of the sense amplifier by using the multiplexer.

According to an embodiment, the electronic device may further include an external power supply electrically connected with the other end of the at least one sensing line, and the display driver integrated circuit may apply the first voltage to the other end of the at least one sensing, line by using the external power supply.

According to an embodiment, the display driver integrated circuit may further include a power switch disposed between the external power supply and the at least one sensing line, and may turn on the power switch such that the first voltage is applied to the other end of the at least one sensing line from the external power supply in response to the received specified signal.

According to an embodiment, the electronic device may further include second group lines crossing the at least one sensing line and providing a gate voltage to each of the plurality of pixels, the display driver integrated circuit may further include a plurality of gate amplifiers electrically connected with the second group lines and providing the gate voltage to each of the plurality of pixels, may sequentially apply the first voltage to the other end of the at least one sensing line by sequentially using the plurality of source amplifiers and the plurality of gate amplifiers one by one according to a specified time interval, and may sequentially check whether or not the plurality of source amplifiers and the plurality of gate amplifiers are abnormal based on the difference between the first voltage and the second voltage, according to the specified time interval.

According to an embodiment, the plurality of source amplifiers may further include first group source switches respectively disposed at output terminals of the plurality of source amplifiers, the plurality of gate amplifiers may further include first group gate switches respectively disposed at output terminals of the plurality of gate amplifiers, and the display driver integrated circuit may sequentially apply the first voltage to the other end of the at least one sensing line according to the specified time interval by sequentially turning on the first group source switches and the first group gate switches one by one according to the specified time interval.

According to an embodiment, the electronic device may further include an external power supply supplying a specified voltage, the display panel may further include first group transistors electrically connecting the external power supply with each of the first group lines, the display driver integrated circuit may further include a gate amplifier for applying a gate voltage to gate terminals of the first group transistors, and second group switches disposed on the first group lines to selectively connect the first group transistors with at least one sensing line, and the display driver integrated circuit may apply the gate voltage to the gate terminals of the first group transistors by using the gate amplifier such that the first group transistors are turned on in response to the received specified signal, may sequential turn on the second group switches one by one according to the specified time interval, may sequentially apply the first voltage to the other end of the at least one sensing line through any one of the first group transistors and any one of the first group lines by using the external power supply according to the specified interval, and may sequentially check whether or not the plurality of pixels are cracked based on the difference between the first voltage and the second voltage, according to the specified time interval.

According to an embodiment, each of the plurality of pixels may include a plurality of sub-pixels electrically connected with the source amplifiers through the first group lines, and the display driver integrated circuit may further include first group sharing switches disposed between at least some of the first group lines on the sensing line such that the sub-pixels included in any one of the plurality of pixels are selectively connected with each other, and may turn on the first group switches and the first group sharing switches such that the at least one sensing line is short-circuited from the other end of the at least one sensing line to the sensing circuit.

According to an embodiment, each of the plurality of pixels may include plurality of sub-pixels electrically connected with the source amplifiers through the first group lines, and the display driver integrated circuit may further include first group sharing switches disposed between at least some of the first group lines on the sensing line such that at least sub-pixels having the same characteristic among the plurality of sub-pixels are selectively connected with each other, and may turn on the first group switches and the first group sharing switches such that the at least one sensing line is short-circuited from the other end of the at least one sensing line to the sensing circuit.

A display according to an embodiment of the present disclosure may include a display panel including a plurality of pixels each including a plurality of sub-pixels, a plurality of source amplifiers electrically connected with the plurality of sub-pixels, first group source switches disposed on an electrical path between the output terminals of the plurality of source amplifiers and the plurality of sub-pixels, first group sharing switches selectively connecting the plurality of sub-pixels included in each of the plurality of pixels with each other, first group switches selectively connecting the plurality of pixels with each other, a sensing circuit selectively connected with the plurality of sub pixels or the plurality of source amplifiers through the first group source switches, the first group sharing switches, and the first group switches, and a display driver integrated circuit electrically connected with input terminals of the plurality of source amplifiers and the sensing circuit, in which the display driver integrated circuit may be configured to supply a first voltage to a first source amplifier of the plurality of source amplifiers in a state in which a first source switch corresponding to the first amplifier, at least some of the first group sharing switches, and at least some of the first group switches are turned on, sense a second voltage obtained by transmitting the first voltage to the sensing circuit through the specified first source switch, the at least some of the first group sharing switches, and the at least some of the first group switches by using the sensing circuit and check information regarding a crack in the display at least based on the sensed second voltage.

According to an embodiment, the display driver integrated circuit may be configured to supply the specified voltage to the specified source amplifier in a state in which remaining source switches other than the source switch among the first group source switches are turned on.

According to an embodiment, the display driver integrated circuit may be configured to supply a third voltage to second source amplifier of the plurality source amplifiers in a state in which a second source switch corresponding to the second amplifier, at least some of the first group sharing switches, and at least some of the first group switches, sense a fourth voltage obtained by transmitting the first voltage to the sensing circuit through the specified first source, the at least some of the first group sharing switches, and the at least some of the first group switches, and check information regarding a crack in the display at least based on the sensed second voltage and the sensed fourth voltage.

A display according to an embodiment of the present disclosure may including a display panel that includes a plurality of pixels including a plurality of sub-pixels, one or more source amplifiers electrically connected with the plurality of sub-pixels, a power supply electrically connected with output terminals of the plurality of sub-pixels and the one or more source amplifiers, first group sharing switches selectively connecting the plurality of sub-pixels included in each of the plurality of pixels, first group switches selectively connecting the plurality of pixels with each other, a sensing circuit selectively connected with the plurality of sub-pixels or the one or more source amplifiers through the first group sharing switches and the first group switches, and a display driver integrated circuit electrically connected with input terminals of the one or more source amplifiers and the sensing circuit, in which the display driver integrated circuit may be configured to turn on at least some of the first group sharing switches and at least some of the first group switches, sense a second voltage obtained by transmitting the first voltage supplied from the power supply device to the sensing circuit through the at least some of the first group sharing switches and the at least some of the first group switches, and check information regarding a crack in the display at least based on the sensed second voltage.

According to an embodiment, the electronic device may further include a power switch disposed at an output terminal of the power supply, and the display driver integrated circuit may turn on the power switch such that the first voltage is supplied from the power supply.

According to embodiments disclosed in the present disclosure, an electronic device may check cracks in display even in the final assembly step. In this way, a defective rate for an electronic device provided to a user may be reduced.

The electronic device according to various embodiments may be one of various types of electronic devices. The electronic devices may include, for example, a portable communication device (e.g., a smart phone), a computer device, portable multimedia device, a port e medical device, camera, a wearable device or a home appliance. According to an embodiment of the disclosure, the electronic devices are not limited to those described above.

It should be appreciated that various embodiments of the present disclosure and the terms used therein are not intended to limit the technological features set forth herein to particular embodiments and include various changes, equivalents, or replacements for a corresponding embodiment. With regard to the description of the drawings, reference numerals may be used to refer to similar or related elements. It is to be understood that a singular form of a noun corresponding to an item may include one or more of the things, unless the relevant context clearly indicates otherwise. As used herein, each of such phrases as "A or B," "at least one of A and B," "at least one of A or B," "A, B, or C," "at least one of A, B, and C," and "at least one of A, B, or C," may include all possible combinations of the items enumerated together in a corresponding, one of the phrases. As used herein, such terms as "1st" and "2nd," or "first" and "second" may be used to simply distinguish a corresponding component from another, and does not limit the components in other aspect importance or order). It is to be understood that if an element (e.g., a first element) is "communicatively", as "coupled with," "coupled to," "connected with," or "connected to" another element (e.g., a second element), it means that the element may be coupled with the other element directly (e.g., wiredly), wirelessly or via a third element.

As used her in, the term "module" may include a unit implemented in hardware, software, or firmware, and may interchangeably be used with other terms, for example, "logic," "logic block," "part," or "circuitry". A module may be a single integral component, or a minimum unit or part thereof, adapted to perform one or more functions. For example, according to an embodiment, the module may be implemented in a form of an application-specific integrated circuit (ASIC).

Various embodiments as set forth herein may be implemented as software (e.g., the program **840**) including one or more instructions that are stored in a storage medium (e.g., internal memory **836** or external memory **838**) that is readable by a machine (e.g., the electronic device **801**). For example, a processor (e.g., the processor **820**) of the machine (e.g., the electronic device **801**) may invoke at least one of the one or more instructions stored in the storage medium, and execute it, with or without using one or more other components under the control of the processor. This allows the machine to be operated to perform at least one function according to the at least one instruction invoked. The one or more instructions may include a code generated by a complier or a code executable by an interpreter. The machine-readable storage medium may be provided in the form of a non-transitory storage medium. Wherein, the term "non-transitory" simply means that the storage medium is a tangible device, and does not include a signal (e.g., an electromagnetic wave), but this term does not differentiate between where data is semi-permanently stored in the storage media and where the data is temporarily stored in the storage medium.

According to an embodiment, a method according to various embodiments of the disclosure may be included and provided in a computer program product. The computer program product may be traded as a product between a seller and a buyer. The computer program product may be distributed in the form of a machine-readable storage medium (e.g., compact disc read only memory (CD-ROM)), or be distributed (e.g., downloaded or uploaded) online via an application store (e.g., Play Store™), or between two user devices (e.g., smart phones) directly. If distributed online, at least part of the computer program product may be temporarily generated or at least temporarily stored in the machine-readable storage medium, such as memory of the manufacturer's server, a server of the application store, or a relay server.

According to various embodiments, each component (e.g., a module or a program) of the above-described components may include single entity or multiple entities. According to various embodiments, one or more of the above-described components may be omitted, or one or more other components may be added. Alternatively or additionally, a plurality of components (e.g., modules or programs) may be integrated into a single component. In such a case, according to various embodiments, the integrated component may still perform one or more functions of each of the plurality of components in the same or similar manner as they are performed by a corresponding one of the plurality of components before the integration. According to various embodiments, operations performed by the module, the program, or another component may be carried out sequentially, in parallel, repeatedly, or heuristically, or one or more of the operations may be executed in a different order or omitted, or one or more other operations may be added.

The invention claimed is:

1. An electronic device comprising:

a display panel on which a plurality of pixels are arranged;

first group lines providing a source voltage to each of the plurality of pixels;

a display driver integrated circuit that includes a plurality of source amplifiers electrically connected with the first group lines and providing the source voltage to each of the plurality of pixels, at least one sensing line crossing the first group lines, and first group switches disposed on the at least one sensing line; and

a sensing circuit electrically connected with one end of the at least one sensing line to check a crack in at least partial region of the electronic device,

wherein the display driven integrated circuit:

receives a specified signal for the electronic device to enter a sense mode;

applies a first voltage to the other end of the at least one sensing line that is distinguished from the one end of the at least one sensing line, in response to the received specified signal;

turns on the first group switches such that the at least one sensing line is short-circuited from the other end of the at least one sensing line to the sensing circuit;

obtains a second voltage sensed by the sensing circuit electrically connected with the one end of the at least one sensing line; and

checks information regarding the crack in the at least partial region of the electronic device based on a difference between the first voltage and the second voltage.

2. The electronic device of claim **1**, wherein the display driver integrated circuit applies the first voltage to the other end of the at least one sensing line by using any one of the plurality of source amplifiers, in response to the received specified signal.

3. The electronic device of claim **2**, wherein the plurality of source amplifiers further include first group source switches respectively disposed at output terminals of the plurality of source amplifiers, and

the display driver integrated circuit turns on the source switch disposed at the output terminal of any one of the source amplifiers among the first group source switches, in response to the received specified signal.

4. The electronic device of claim **2**, wherein the display driver integrated circuit:

further includes a multiplexer electrically connected with an input terminal of any one of the source amplifiers, and

adjusts a magnitude of the output voltage of the one of the source amplifiers by using the multiplexer.

5. The electronic device of claim **2**, wherein the display driver integrated circuit:

sequentially applies the first voltage to the other end of the at least one sensing line by sequentially using the plurality of source amplifiers one by one according to a specified time interval, and

sequentially checks whether or not each of the plurality of source amplifiers is abnormal based on the difference between the first voltage and the second voltage, according to the specified time interval.

6. The electronic device of claim **5**, wherein the plurality of source amplifiers further include first group source switches respectively disposed at output terminals of the plurality of source amplifiers, and

the display driver integrated circuit sequentially applies the first voltage to the other end of the at least one sensing line according to the specified time interval by sequentially turning on the first group source switches one by one according to the specified time interval.

7. The electronic device of claim **1**, wherein the display driver integrated circuit:

further includes a sense amplifier electrically connected with the other end of the at least one sensing line, and

applies the first voltage to the other end of the at least one sensing line by using the sense amplifier, in response to the received specified signal.

8. The electronic device of claim **7**, wherein the display driver integrated circuit:

further includes a multiplexer electrically connected with an input terminal of the sense amplifier, and

adjusts a magnitude of the output voltage of the sense amplifier by using the multiplexer.

9. The electronic device of claim **1**, further comprising:

an external power supply electrically connected with the other end of the at least one sensing line,

wherein the display driver integrated circuit applies the first voltage to the other end of the at least one sensing line by using the external power supply.

10. The electronic device of claim **9**, wherein the display driver integrated circuit:

further includes a power switch disposed between the external power supply and the at least one sensing line, and

turns on the power switch such that the first voltage is applied to the other end of the at least one sensing line from the external power supply in response to the received specified signal.

11. The electronic device of claim 1, further comprising:

second group lines crossing the at least one sensing line and providing a gate voltage to each of the plurality of pixels,

wherein the display driver integrated circuit:

further includes a plurality of gate amplifiers electrically connected with the second group lines and providing the gate voltage to each of the plurality of pixels,

sequentially applies the first voltage to the other end of the at least one sensing line by sequentially using the plurality of source amplifiers and the plurality of gate amplifiers one by one according to a specified time interval, and

sequentially checks whether or not the plurality of source amplifiers and the plurality of gate amplifiers are abnormal based on the difference between the first voltage and the second voltage, according to the specified time interval.

12. The electronic device of claim 11, wherein the plurality of source amplifiers further include first group source switches respectively disposed at output terminals of the plurality of source amplifiers,

the plurality of gate amplifiers further include first group gate switches respectively disposed at output terminals of the plurality of gate amplifiers, and

the display driver integrated circuit sequentially applies the first voltage to the other end of the at least one sensing line according to the specified time interval by sequentially turning on the first group source switches and the first group gate switches one by one according to the specified time interval.

13. The electronic device of claim 1, further comprising:

an external power supply supplying a specified voltage,

wherein the display panel further includes first group transistors electrically connecting the external power supply with each of the first group lines,

the display driver integrated circuit further includes a gate amplifier for applying a gate voltage to gate terminals of the first group transistors, and second group switches disposed on the first group lines to selectively connect the first group transistors with at least one sensing line, and

the display driver integrated circuit:

applies the gate voltage to the gate terminals of the first group transistors by using the gate amplifier such that the first group transistors are turned on in response to the received specified signal,

sequentially turns on the second group switches one by one according to the specified time interval,

sequentially applies the first voltage to the other end of the at least one sensing line through any one of the first group transistors and any one of the first group lines by using the external power supply according to the specified time interval, and

sequentially checks whether or not the plurality of pixels are cracked based on the difference between the first voltage and the second voltage, according to the specified time interval.

14. The electronic device of claim 1, wherein each of the plurality of pixels includes a plurality of sub-pixels electrically connected with the source amplifiers through the first group lines, and

the display driver integrated circuit:

further includes first group sharing switches disposed between at least some of the first group lines on the sensing line such that the sub-pixels included in any one of the plurality of pixels are selectively connected with each other, and

turns on the first group switches and the first group sharing switches such that the at least one sensing line is short-circuited from the other end or the at least one sensing line to the sensing circuit.

15. The electronic device of claim 1, wherein each of the plurality of pixels includes a plurality of sub-pixels electrically connected with the source amplifiers through the first group lines, and

the display driver integrated circuit:

further includes first group sharing switches disposed between at least some of the first group lines on the sensing line such that at least sub-pixels having the same characteristic among the plurality of sub-pixels are selectively connected with each other, and

turns on the first group switches and first group sharing switches such that the at least one sensing line is short-circuited from the other end of the at least one sensing line to the sensing circuit.

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